

Illicit Discharge Detection and Elimination (IDDE) Plan

Town of Barnstable, Massachusetts

**Prepared June 30, 2019
Revised June 30, 2022**

Prepared For:

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Illicit Discharge Detection and Elimination (IDDE) Plan Revision Log

Revision Date	Section(s) Revised	Revisions Made	Revisions Made by
June 30, 2019	All	Original IDDE Plan prepared.	Comprehensive Environmental Inc.
June 30, 2021	Appendix H	Dry weather outfall screening data.	Comprehensive Environmental Inc.
June 30, 2022	1.4 and appendices	Impaired waterbodies in Table 1-1, appendices associated with mapping, outfall screening, and training.	Comprehensive Environmental Inc.

Table of Contents

Illicit Discharge Detection & Elimination Plan – Town of Barnstable

1	Introduction	1
1.1	IDDE Regulatory Background	1
1.2	Illicit Discharges.....	1
1.3	Allowable Non-Stormwater Discharges.....	2
1.4	Receiving Waters and Impairments.....	3
1.5	IDDE Program Purpose, Goals, Framework, and Work Complete	5
1.6	How to Use this Plan.....	6
2	Authority and Statement of IDDE Responsibilities	9
2.1	Legal Authority	9
2.2	Statement of Responsibilities	9
3	Stormwater System Mapping.....	10
3.1	Phase I Mapping	10
3.2	Phase II Mapping.....	10
3.3	Additional Recommended Mapping Elements	11
4	Sanitary Sewer Overflows (SSOs).....	12
5	Assessment and Priority Ranking of Outfalls	13
5.1	Outfall Catchment Delineations	13
5.2	Outfall and Interconnection Inventory and Initial Ranking	13
6	Dry Weather Outfall Screening and Sampling	16
6.1	When to Inspect: Weather Conditions	16
6.2	What to Look For: Physical Characteristics.....	16
6.3	What to Sample.....	18
6.3.1	Field Equipment.....	21
6.4	Interpreting Outfall Sampling Results	21
6.5	Follow-up Ranking of Outfalls and Interconnections	23
7	Catchment Investigations	24
7.1	Dry Weather Key Junction Structure Inspections	24
7.1.1	When to Inspect	25
7.1.2	What to Look For: Physical Characteristics	25
7.1.3	What to Sample.....	25
7.1.4	Interpreting Key Junction Inspection Results.....	25
7.2	System Vulnerability Factors and Wet Weather Sampling.....	26
7.2.1	When to Sample: Wet Weather Conditions.....	27
7.2.2	What to Sample: Wet Weather Conditions.....	27
7.2.3	Interpreting Wet Weather Sampling Results	28
8	Source Investigations.....	29
8.1	Field Reviews.....	29
8.2	Sandbagging	29
8.3	Smoke Testing.....	30

8.4	Dye Testing	30
8.5	CCTV/Video Inspection	31
8.6	Optical Brightener Monitoring	31
9	Illicit Discharge Removal.....	33
9.1	Removal Options.....	33
9.1.1	Voluntary Elimination	33
9.1.2	Legal Enforcement.....	33
9.2	Reporting	33
9.3	Confirmatory Outfall Screening	34
9.4	Ongoing Screening.....	34
9.5	IDDE Prevention.....	34
10	Training	35
11	Progress Reporting	36
11.1	Program Activity and Timeline.....	36
11.2	Annual Recordkeeping.....	37

Tables

Table 1-1.	Impaired Waters	3
Table 6-1.	Physical Observation Parameters and Likely Flow Sources	17
Table 6-2.	Sampling Parameters and Analysis Methods for All Waterbodies	19
Table 6-3.	Additional Sampling Parameters for Discharges to Impaired.....	20
Table 6-4.	Field Equipment – Dry Weather Outfall Screening and Sampling.....	21
Table 6-5.	Benchmark Field Measurements for Select Parameters.....	22
Table 6-6.	Outfall Discharge Designation and Follow-Up Action.....	22
Table 7-1.	Key Junction Discharge Designation and Follow-Up Action	26
Table 8-1.	Tips for Successful Dye Testing	32

Figures

Figure 1-1.	Urbanized Area	6
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Appendices

Appendix A.	Stormwater System Mapping
Appendix B.	SSO Inventory
Appendix C.	IDDE Outfall Classification/Ranking and Vulnerability Assessment
Appendix D.	SOP for Dry Weather Outfall Investigation/Sampling
Appendix E.	SOP for Illicit Discharge Source Investigation
Appendix F.	SOP for Dry Weather Key Junction Investigation/Sampling
Appendix G.	SOP for Wet Weather Outfall Sampling
Appendix H.	Field Evaluation Records
Appendix I.	IDDE Employee Training Records

1 Introduction

1.1 IDDE Regulatory Background

This Illicit Discharge Detection and Elimination (IDDE) Plan has been developed by the Town of Barnstable to address the requirements of the United States Environmental Protection Agency's (EPA's) 2016 National Pollutant Discharge Elimination System (NPDES) General Permit for Stormwater Discharges from Small Municipal Separate Storm Sewer Systems (MS4) in Massachusetts, hereafter referred to as the "2016 MS4 Permit." The 2016 Massachusetts MS4 Permit was signed on April 4, 2016 and has an effective date of July 1, 2018, and more recently updated on December 7, 2020 with an effective date of January 6, 2021. After several years of litigation, the permit was updated in December 2020 with a revised effective date of January 6, 2021. Authorization to discharge was set to expire on July 1, 2022, however, was administratively continued by EPA. The permit was cosigned by the Massachusetts Department of Environmental Protection (MassDEP) and thus is jointly regulated by EPA and MassDEP.

The 2016 Massachusetts MS4 Permit requires that each permittee, or regulated community, address six Minimum Control Measures (MCMs). These measures include the following:

1. Public Education and Outreach;
2. Public Involvement and Participation;
3. Illicit Discharge Detection and Elimination Program;
4. Construction Site Stormwater Runoff Control;
5. Stormwater Management in New Development and Redevelopment (Post Construction Stormwater Management); and
6. Good Housekeeping and Pollution Prevention for Permittee Owned Operations.

Under MCM 3, the permittee is required to implement an IDDE program to systematically find and eliminate sources of non-stormwater discharges to its municipal separate storm sewer system and implement procedures to prevent such discharges. The IDDE program must be recorded in a written (hardcopy or electronic) document. This IDDE Plan has been prepared to address this requirement.

1.2 Illicit Discharges

An "illicit discharge" is any discharge to a MS4 that is not composed entirely of stormwater except non-stormwater discharges pursuant to a NPDES permit and discharges resulting from fire-fighting activities.

Illicit discharges may take a variety of forms. Illicit discharges may enter the drainage system through direct or indirect connections. Direct connections may be relatively obvious, such as cross-connections of a sewer service pipe to the storm drain system. Indirect illicit discharges may be more difficult to detect or address, such as a cracked pipe, leaking tank; failing septic systems that discharge untreated sewage to a ditch within the MS4, or a sump pump that discharges contaminated water on an intermittent basis.

Some illicit discharges are intentional, such as dumping used oil (or other pollutant material) into catch basins, a resident or contractor illegally tapping a sewer lateral into a storm drain pipe to avoid the costs of a sewer connection fee and service, and illegal dumping of yard wastes into surface waters. Some illicit discharges are related to the unsuitability of original infrastructure to the modern regulatory environment. Examples of illicit discharges in this category include connected floor drains in old buildings, as well as sanitary sewer overflows that enter the drainage system. Sump pumps legally connected to the storm drain system can also be an illicit discharge if used inappropriately, such as for the disposal of floor wash water or old household products, in many cases due to a lack of understanding on the part of the homeowner.

Common illicit discharges can include the following:

- Sanitary wastewater from crushed, cracked, or collapsed pipes or from surcharges;
- Sewer lines from a house, basement, or individual bathroom to a storm drain;
- Overflow or seepage from septic tanks;
- Cross connections between a sewer or combined sewer line and the storm system;
- Commercial vehicle wash wastewater; and/or
- Improper disposal of automobile and household products.

Elimination of some discharges may require substantial costs and efforts, such as funding and designing a project to reconnect sanitary sewer laterals. Others, such as improving self-policing of dog waste management, can be accomplished by outreach in conjunction with the minimal additional cost of dog waste bins and the municipal commitment to dispose of collected materials on a regular basis. Regardless of the intention, when not addressed, illicit discharges can contribute high levels of pollutants, such as heavy metals, toxics, oil, grease, solvents, nutrients, and/or pathogens to surface waters. Thus, the 2016 MS4 Permit requires a program to identify, locate and remove illicit discharges.

1.3 Allowable Non-Stormwater Discharges

The following categories of non-storm water discharges are allowed under the MS4 Permit unless the permittee, EPA or MassDEP identifies any category or individual discharge of non-stormwater discharge as a significant contributor of pollutants to the MS4:

- | | |
|--|--|
| • Water line flushing; | • Foundation drains; |
| • Landscape irrigation; | • Air conditioning condensation; |
| • Diverted stream flows; | • Irrigation water, springs; |
| • Rising ground water; | • Water from crawl space pumps; |
| • Uncontaminated pumped groundwater; | • Footing drains; |
| • Discharge from potable water sources; | • Lawn watering; |
| • Uncontaminated ground water infiltration (as defined at 40 CFR 35.2005(20)); | • Individual resident car washing |
| | • Flows from riparian habitats and wetlands; |
| | • De-chlorinated swimming pool discharges; |

- Street wash waters; and
- Residential building wash waters without detergents.

If these discharges are identified as significant contributors to the MS4, they must be considered an “illicit discharge” and addressed under the IDDE Program (i.e., control these sources so they are no longer significant contributors of pollutants, and/or eliminate them entirely).

1.4 Receiving Waters and Impairments

As part of the 2016 MS4 Permit, communities must implement specific actions and BMPs to address waters with an approved Total Maximum Daily Load (TMDL) as of the issuance date of the permit (April 4, 2016) and to address water quality limited waters, including but not limited to waters listed in categories 4 or 5 on the most recent EPA-approved Massachusetts Clean Water Act section 303(d) list or Massachusetts Integrated Report of water under Clean Water Act section 305(b). IDDE requirements include consideration of these waters in the prioritization of IDDE activities and sampling programs.

Table 1-1 lists the “impaired waters” within the boundaries of Barnstable’s regulated area based on the Final Massachusetts Integrated List of Waters produced by MassDEP every two years¹. Impaired waters are water bodies that do not meet water quality standards for one or more designated use(s) such as recreation or aquatic habitat.

Table 1-1. Impaired Waters

Waterbody Name	Segment ID and Category		Impairment(s)	Approved TMDL ²
Barnstable Harbor	MA96-01	4a	Fecal Coliform	36771
Bearse Pond	MA96012	4a	(Fanwort*)	
			Mercury in Fish Tissue	42393
Bumps River	MA96-02	4a	Fecal Coliform	36771
Centerville River	MA96-04	4a	Estuarine Bioassessments	33858
			Fecal Coliform	36771
			Nitrogen (Total)	33858
Cotuit Bay	MA96-63	4a	Fecal Coliform	36582
			Nitrogen (Total)	33988
Halls Creek	MA96-93	4a	Fecal Coliform	42356
Hyannis Inner Harbor	MA96-82	4a	Fecal Coliform	42357
			Nitrogen (Total)	64145
Mill Creek	MA96-37	4a	Fecal Coliform	36771
Mill Creek	MA96-80	4a	Fecal Coliform	42365
			Nitrogen (Total)	64148 & 9

¹At the time of preparation of this plan, the 2020/2022 303d list is the most up to date finalized 303d List.

²“Approved TMDLs” are those that have been approved by EPA as of the date of issuance of the 2016 Permit.

Table 2-1 (continued). Impaired Waters

Waterbody Name	Segment ID and Category		Impairment(s)	Approved TMDL
North Bay	MA96-66	4a	Estuarine Bioassessments	33990
			Fecal Coliform	36584
Popponesset Bay	MA96-40	4a	Estuarine Bioassessments	33967-9
Prince Cove	MA96-07	4a	Estuarine Bioassessments	33991-3
			Fecal Coliform	36585
Santuit River	MA96-92	4a	Fecal Coliform	42360
Seapuit River	MA96-64	4a	Fecal Coliform	36583
Shoestring Bay	MA96-08	4a	Estuarine Bioassessments	33966
			Fecal Coliform	36771
Snows Creek	MA96-81	4a	Fecal Coliform	42361
Stewarts Creek	MA96-94	4a	Fecal Coliform	42363
West Bay	MA96-65	4a	Estuarine Bioassessments	33989
Wequaquet Lake	MA96333	4a	(Fanwort*)	
			(Fish Passage Barrier*)	
			Mercury in Fish Tissue	33880
Lake Elizabeth	MA96080	4c	(Fish Passage Barrier*)	
Long Pond	MA96184	4c	(Non-Native Aquatic Plants*)	
Unnamed Tributary	MA96-128	4c	(Fish Passage Barrier*)	
Unnamed Tributary	MA96-132	4c	(Fish Passage Barrier*)	
Centerville Harbor	MA96-03	5	Estuarine Bioassessments	
Hamblin Pond	MA96126	5	Mercury in Fish Tissue	33880
			Oxygen, Dissolved	
			Harmful Algal Blooms	
Hyannis Harbor	MA96-05	5	Estuarine Bioassessments	
Lewis Bay	MA96-36	5	Estuarine Bioassessments	64146 & 7
			Fecal Coliform	36771
			Nitrogen (Total)	
			Nutrient/Eutrophication Biological Indicators	
Little River	MA96-99	5	(Fish Passage Barrier*)	
			Escherichia coli	
Lovells Pond	MA96185	5	(Fish Passage Barrier*)	
			Chlorophyll-a	
			Harmful Algal Blooms	
			Oxygen, Dissolved	
			Phosphorus (Total)	
			Turbidity, Transparency/Clarity	
Maraspin Creek	MA96-06	5	Fecal Coliform	36771
			Nutrient/Eutrophication Biological Indicators	
Middle Pond	MA96198	5	(Curly-leaf Pondweed*)	
			Oxygen, Dissolved	
			Harmful Algal Blooms	

Table 2-1 (continued). Impaired Waters

Waterbody Name	Segment ID and Category		Impairment(s)	Approved TMDL
Mystic Lake	MA96218	5	(Non-Native Aquatic Plants*)	
			Oxygen, Dissolved	
Red Lily Pond	MA96257	5	(Aquatic Plants (Macrophytes)*)	
			Fecal Coliform	
			Nutrient/Eutrophication Biological Indicators	
Santuit River	MA96-91	5	(Fish Passage Barrier*)	
			Temperature	
Unnamed Tributary	MA96-100	5	Escherichia coli	

Category 4a Waters – impaired waters with a completed TMDL.

Category 4c Waters – impaired waters where the impairment is not caused by a pollutant. No TMDL required.

Category 5 Waters – impaired waters that require a TMDL.

*TMDL not required (Non-pollutant)

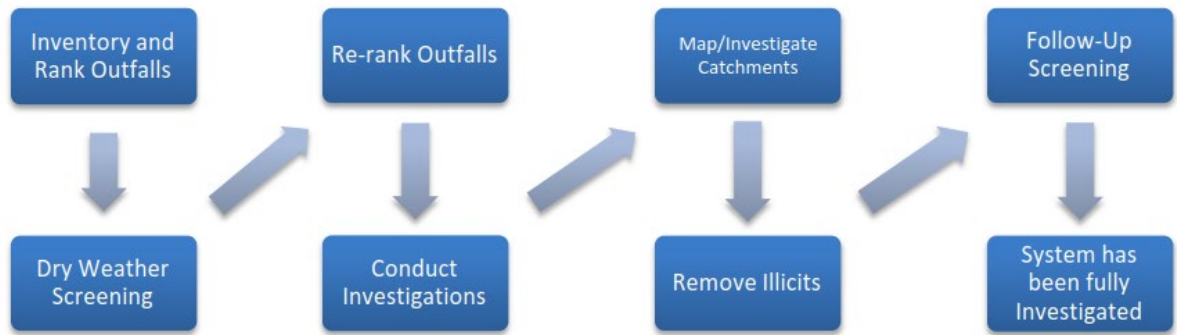
1.5 IDDE Program Purpose, Goals, Framework, and Work Complete

The purpose of this plan is to document the Town’s IDDE program and to assist field staff and program staff with the proper identification, reporting, and resolution of pollution problems. A locus map with the regulated Urbanized Area shown is provided as **Figure 1-1** at the end of this section.

The goals of the IDDE program are to find and eliminate illicit discharges to the municipal separate storm sewer system and to prevent illicit discharges from happening in the future. The program consists of the following major components as outlined in the 2016 MS4 Permit:

- Legal authority and regulatory mechanism to prohibit illicit discharges and enforce this prohibition;
- Storm system mapping;
- Inventory and ranking of outfalls;
- Dry weather outfall screening;
- Catchment investigations;
- Identification/confirmation of illicit sources;
- Illicit discharge removal;
- Follow-up screening; and
- Employee training.

The general IDDE investigation procedure framework is shown below:

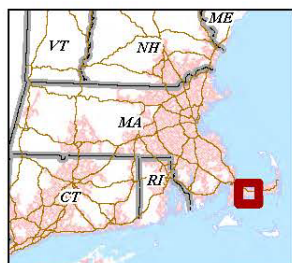


1.6 How to Use this Plan

This plan is intended to be used by Town of Barnstable staff whose job involves frequent field or site visits, as well as staff responsible for administering the MS4 permit. This primarily consists of staff from the Department of Public Works and the Public Health Division, with mapping support provided by the IT-GIS department. This plan is divided into several sections and includes the following components:

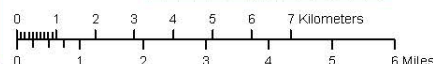
- Section 2 Authority and Statement of IDDE Responsibilities** – references the Town’s legal authority to regulate illicit connections and discharges and identifies Town staff responsible for IDDE Program components.
- Section 3 Stormwater System Mapping** – outlines the procedures for completing required stormwater system mapping, as well as additional recommendations in the 2016 MS4 Permit.
- Section 4 Sanitary Sewer Overflows (SSOs)** – provides an inventory of known SSOs that have discharged to the MS4 and then to waterways within the five (5) years prior to the effective date of the 2016 MS4 Permit, and outlines the procedures for their elimination.
- Section 5 Assessment and Priority Ranking of Outfalls** – assesses and ranks each outfall catchment area for illicit discharge potential. The ranking is used to prioritize IDDE investigations.
- Section 6 Dry Weather Outfall Screening and Sampling** – outlines the procedures for performing outfall screening investigations during dry weather.
- Section 7 Catchment Investigations** – details various additional investigations used to locate evidence of illicit discharges or SSOs and to isolate and confirm the source of the potential discharge within the outfall catchment area.
- Section 8 Source Investigations** – describes methods for identifying the source of an illicit discharge.

- Section 9** **Illicit Discharge Removal** – describes methods for illicit discharge removal, as well as subsequent confirmation screening and discharge prevention.
- Section 10** **Training** – details the minimum IDDE training that is made available to all employees involved in the IDDE program.
- Section 11** **Progress Reporting** – outlines the scope of annual progress reports which evaluates the progress and success of the IDDE program.



**NPDES Phase II Stormwater Program
Automatically Designated MS4 Areas
*Barnstable Town MA***

Regulated Area:



Town Population: **45121**
Regulated Population: **43576**
(Populations estimated from 2010 Census)



Urbanized Areas, Town Boundaries:
US Census (2000, 2010)
Base map © 2013 Microsoft Corporation
and its data suppliers

US EPA Region 1 GIS Center Map #8824, 8/9/2013

Figure 1-1. Urbanized Area

2 Authority and Statement of IDDE Responsibilities

2.1 Legal Authority

The Town of Barnstable is currently in the process of updating and instituting bylaws that will better establish legal authority for enforcement of IDDE requirements as required under the 2016 MS4 Permit and will be provided in the Stormwater Management Program (SWMP) Plan. This update to regulatory mechanisms will provide the Town of Barnstable with adequate legal authority as required to comply with 2016 MS4 Permit requirements, including:

- Prohibiting illicit discharges and unauthorized discharges to the MS4;
- Investigating suspected illicit discharges;
- Requiring the removal of all such illicit connections;
- Eliminating illicit discharges, including discharges from properties not owned by or controlled by the MS4 that discharge into the MS4 system; and
- Implementing appropriate enforcement procedures and actions.

2.2 Statement of Responsibilities

The Department of Public Works (DPW) and the Public Health Division is responsible for implementing the IDDE program. IDDE Program Responsibilities include:

- Drainage system mapping (DPW, Information Technology -GIS);
- Determining and inspecting key junction manholes (DPW, Public Health Division);
- Catchment delineation and prioritization for field screening (DPW, Public Health Division);
- Dry and wet weather outfall investigations where required (DPW, Public Health Division);
- Performing systematic catchment investigations (DPW, Public Health Division);
- Investigating and eliminating IDDE sources (DPW, Public Health Division);
- Enforcing IDDE ordinance requirements (DPW, Public Health Division);
- Tracking illicit discharge connections and removals for annual reporting (DPW, Public Health Division);
- Incorporating IDDE into public education efforts (DPW, Public Health Division); and
- Providing annual employee training (DPW, Public Health Division).

3 Stormwater System Mapping

The 2016 MS4 Permit requires a detailed storm system map to facilitate identification of key infrastructure, factors influencing proper system operation, and the potential for illicit discharges. The 2016 MS4 Permit requires the storm system map to be developed in two phases as outlined below. The Department of Public Works and the Town's Information Technology – GIS Department is responsible for developing the stormwater system mapping pursuant to the 2016 MS4 Permit. The status of Barnstable's stormwater infrastructure mapping is provided in **Appendix A** along with a copy of the map. The Town of Barnstable reports on the progress towards completion of the storm system map in each annual report with updates to the stormwater mapping included in **Appendix A**.

3.1 Phase I Mapping

Phase I mapping must be completed within two (2) years of the effective date of the permit (July 1, 2020) and include the following information:

- Outfalls and receiving waters (previously required by the MS4-2003 permit);
- Open channel conveyances (swales, ditches, etc.);
- Interconnections with other MS4s and other storm sewer systems;
- Municipally owned stormwater treatment structures;
- Waterbodies identified by name with a list of impairments as identified on the most recent EPA approved Massachusetts Integrated List of Waters report; and
- Initial catchment delineations. Topographic contours and drainage system information may be used to produce initial catchment delineations.

3.2 Phase II Mapping

Phase II mapping must be completed within ten (10) years of the effective date of the permit (July 1, 2028) and include the following information:

- Outfall locations (latitude and longitude with a minimum accuracy of +/-30 feet);
- Pipe connectivity;
- Manholes;
- Catch basins;
- Refined catchment delineations. Catchment delineations must be updated to reflect information collected during catchment investigations;
- Municipal sanitary sewer system; and
- Municipal combined sewer system.

Note that Barnstable has no combined sewer system and thus these mapping components do not apply to the Town's mapping program.

3.3 Additional Recommended Mapping Elements

Although not required, the 2016 MS4 Permit recommends mapping the following items as additional components to the Town of Barnstable's storm system mapping:

- Storm sewer material, size (pipe diameter), age;
- Sanitary sewer system material, size (pipe diameter), age;
- Privately owned stormwater treatment structures;
- Where a municipal sanitary sewer system exists, properties known or suspected to be served by a septic system, especially in high density urban areas;
- Area where the permittee's MS4 has received or could receive flow from septic system discharges;
- Seasonal high-water table elevations impacting sanitary alignments;
- Topography;
- Orthophotography (aerial imagery);
- Alignments, dates and representation of work completed of past investigations; and
- Locations of suspected, confirmed and corrected illicit discharges with dates and flow estimates.

As the Town of Barnstable's IDDE program progresses through the mapping requirements of the next ten years, the Department of Public Works and Public Health Division will assess the feasibility, usefulness, and cost implications of including some or all of the above information into the GIS database. Maps are updated as additional information is obtained.

4 Sanitary Sewer Overflows (SSOs)

The 2016 MS4 Permit requires municipalities to prohibit illicit discharges, including sanitary sewer overflows (SSOs), to the separate storm sewer system. SSOs are discharges of untreated sanitary wastewater from a municipal sanitary sewer that can contaminate surface waters, cause serious water quality problems and property damage, and threaten public health. SSOs can be caused by blockages, line breaks, sewer defects that allow stormwater and groundwater to overload the system, power failures, improper sewer design, and/or vandalism.

The Town of Barnstable annually completes an inventory of SSOs that have discharged to the MS4 within the 5 years prior to the effective date of the 2016 MS4 Permit, based on review of available documentation pertaining to SSOs. The SSO inventory is provided in **Appendix B** and is included in the annual report, including the status of mitigation and corrective measures to address each identified SSO.

5 Assessment and Priority Ranking of Outfalls

The 2016 MS4 Permit requires an assessment and priority ranking of outfalls in terms of their potential to have illicit discharges and SSOs and the related public health significance. The ranking helps determine the priority order for performing IDDE investigations and meeting permit milestones.

5.1 Outfall Catchment Delineations

Catchments for each of the MS4 outfalls³ and interconnections⁴ have been delineated based on available topographic contours and mapped drainage infrastructure to define contributing areas for investigation of potential sources of illicit discharges. Initial catchment delineations are continually refined as additional mapping is completed and to reflect information collected during catchment investigations.

5.2 Outfall and Interconnection Inventory and Initial Ranking

The Town completed an initial outfall and interconnection inventory and priority ranking to assess illicit discharge potential based on existing information. The inventory is periodically updated to include data collected in connection with dry weather screening and other relevant inspections. For the ranking, outfalls and interconnections have been classified into one of the following categories:

1. **Problem Outfalls:** Outfalls/interconnections with known or suspected contributions of illicit discharges based on existing information. This includes any outfalls/interconnections where previous screening indicates likely sewer input. Likely sewer input indicators are any of the following:

- Olfactory or visual evidence of sewage;
- Ammonia ≥ 0.5 mg/L, surfactants ≥ 0.25 mg/L, and bacteria levels greater than the water quality criteria applicable to the receiving water; or
- Ammonia ≥ 0.5 mg/L, surfactants ≥ 0.25 mg/L, and detectable levels of chlorine.

³ **Outfall** means a point source as defined by 40 CFR § 122.2 as the point where the municipal separate storm sewer discharges to waters of the United States. An outfall does not include open conveyances connecting two municipal separate storm sewers or pipes, tunnels or other conveyances that connect segments of the same stream or other waters of the United States and that are used to convey waters of the United States. Culverts longer than a simple road crossing shall be included in the inventory unless the permittee can confirm that they are free of any connections and simply convey waters of the United States.

⁴ **Interconnection** means the point (excluding sheet flow over impervious surfaces) where the permittee's MS4 discharges to another MS4 or other storm sewer system, through which the discharge is conveyed to waters of the United States or to another storm sewer system and eventually to a water of the United States.

Note that Problem Catchments are only identified during the initial round of catchment ranking, and no additional catchments should be added to this category. If future evidence indicates that the above pollutant levels may be present, catchments must be ranked at the top of the High Priority Catchments list. Dry weather screening and sampling is not required for Problem Outfalls.

2. **High Priority Outfalls:** Outfalls/interconnections that have not been classified as Problem Outfalls and that contain any of the following characteristics:
 - Discharging to an area of concern to public health due to proximity of public beaches, recreational areas, drinking water supplies or shellfish beds;
 - Past discharge complaints;
 - Discharges exceeding water quality standards for bacteria; ammonia levels ≥ 0.5 mg/l; surfactants greater ≥ 0.25 mg/l;
 - Sites that have a potential to generate pollutants that could contribute to illicit discharges. Examples of these sites include car dealers, car washes, gas stations, garden centers, industrial manufacturing, etc.;
 - Industrial areas >40 years old where the sanitary sewer system is >40 years old;
 - Areas that were once serviced by septic systems that have been converted to sewer;
 - Areas that were once served by a combined sewer system, but have been separated;
 - Septic systems > 30 years old in residential land use and prone to failure;
 - Any river or stream that is culverted for distances greater than a simple road crossing; and
 - Catchment areas draining to waterbody segments impaired for bacteria and pathogens.
3. **Low Priority Outfalls:** Outfalls/interconnections that do not meet any of the problem outfall, high priority outfall, or excluded (below) outfall criteria.
4. **Excluded outfalls:** Outfalls/interconnections with no potential for illicit discharges. This category is limited to roadway drainage in undeveloped areas with no dwellings and no sanitary sewers; drainage for athletic fields, parks or undeveloped green space and associated parking without services; cross-country drainage alignments (that neither cross nor are in proximity to sanitary sewer alignments) through undeveloped land.

The IDDE prioritization categories, from highest to lowest priority are Problem Outfalls, High Priority Outfalls and Low Priority Outfalls. Excluded Outfalls do not require any investigation. Outfalls that meet criteria in more than one category are automatically assigned the higher of the priority categories. Those within the Problem and High Priority Outfall category are further ranked based on the number of criteria each outfall meets in the respective category. For example, the more criteria the outfall meets, the higher it is ranked in priority. Refer to **Appendix C** for a tabulated breakdown of the current prioritization (classification and ranking) for each outfall and a map identifying the prioritization by area.

The map includes a grid overlay that breaks the Town into sections. The grid overlay is used to prioritize IDDE activities by section of Town (i.e., grid ID), rather than individual outfall, to more efficiently direct inspection activities by area. Classifications and rankings are updated as additional information is collected.

6 Dry Weather Outfall Screening and Sampling

Dry weather flow is a common indicator of potential illicit connections. The MS4 Permit requires all outfalls/interconnections (excluding Problem and excluded Outfalls) be inspected for the presence of dry weather flow. The first step for detecting illicit (non-stormwater) connections in MS4s is to physically observe all regulated outfall discharge points in the field during periods of dry weather. Outfall locations are shown on the Town Drainage System Maps provided in **Appendix A**.

Stormwater discharges to culverted streams that cannot be easily accessed (i.e., underground discharge locations) should be inspected at the nearest upstream location (e.g., manhole structure or the last “downstream” catch basin before the outfall pipe). A comprehensive SOP for Outfall Dry Weather Screening with checklist and forms is included in **Appendix D**. Screening procedures should be implemented starting with High Priority outfalls, followed by Low Priority outfalls, based on the initial priority rankings provided in **Appendix C**. Problem Outfalls do not require screening, rather proceed right to source investigations.

6.1 When to Inspect: Weather Conditions

Dry weather outfall screening and sampling may occur when no more than 0.1 inches of rainfall has occurred in the previous 24-hour period and no significant snow melt is occurring. For purposes of determining dry weather conditions, program staff use precipitation data sources that include the following:

1. Weather Underground station in Barnstable
<https://www.wunderground.com/weather/us/ma/barnstable> or
2. National Oceanic and Atmospheric Administration (NOAA) weather station at Hyannis regional airport, station KHYA.

6.2 What to Look For: Physical Characteristics

Illicit discharges can be intermittent or continuous as defined below:

- **Intermittent** – Intermittent discharges are short in duration, lasting only a short time and then disappearing. Examples include:
 - Materials that have been dumped into a storm drain (catch basin) or drainage way, and
 - A floor drain that is connected to the storm sewer.
- **Continuous** – Continuous discharges continue without changing, stopping, or being interrupted. Examples include:
 - Sanitary wastewater piping that is cross-connected from a building or sanitary sewer line to the storm sewer, and

- An industrial operational discharge that is not permitted.

Some intermittent illicit discharges may only occur in wet weather or when one part of the system overflows. These flows are generally associated with combined sewer and drainage systems that can back up or bypass diversion structures during heavy flows and discharge wastes to the storm drain system, but can also occur with failing septic systems that pond and discharge through the surface. Illicit discharges can be detected at the stormwater outfall, as evident from unusual debris (e.g. toilet paper), stressed vegetation, sheen, etc.

Physical inspections should include observations for flow, and when flow is not present, for potential signs of intermittent illicit discharges. When flow is present, observations on the presence and severity of odor, color, turbidity and floatables should be made and recorded in accordance with the SOP and checklist in **Appendix D**. Observations for other physical indicators should also be made, under flowing and non-flowing conditions, including the condition of the outfall pipe, deposits or stains in the vicinity of the outfall, abnormal vegetation growth, the quality of any pooled water at the outlet and any benthic growth on the pipe. **Table 6-1** describes various physical observation parameters and what they may indicate.

Table 6-1. Physical Observation Parameters and Likely Flow Sources

Parameter	Observations	Interpretation
Odor	Sewage	Stale sanitary wastewater, especially in pools near outfall
	Sulfur (rotten eggs)	Industries that discharge sulfide compounds or organics (meat packers, canneries, dairies, etc.). Also, could be petroleum related “high – sulfur” fuels
	Rancid-sour	Food preparation facilities (restaurants, hotels, etc.)
	Oil and gas	Petroleum refineries or many facilities associated with vehicle maintenance or petroleum product storage
	Chlorine	Pool discharges, washing activities
	Sweet / Fruity	Washing activities
	Sharp, pungent (chemicals)	Hazardous waste
Color	Yellow	Chemical plants, textile and tanning plants
	Brown	Meat packers, printing plants, metal works, stone and concrete, fertilizers, petroleum refining facilities, construction sites, and glass cutting
	Green	Chemical plants, textile facilities, algae/plankton bloom, antifreeze (fluorescent green), fertilizer
	Red	Meat packers, metal works, iron floc (bacterium)
	Gray	Dairies, food processing, sewage, concrete wash-out
	Red, Purple, Blue, Black	Fabric dyes, inks from paper and cardboard manufacturers

Table 6-1 (continued). Physical Observation Parameters and Likely Flow Sources

Parameter	Observations	Interpretation
Turbidity	Cloudy	Sanitary wastewater, concrete or stone operations, fertilizer facilities, automotive dealers
	Opaque	Food processors, lumber mills, metal operations, pigment plants
Floatable Matter	Oil sheen, grease	Petroleum refineries or storage facilities and vehicle service facilities, restaurants
	Sewage	Sanitary wastewater
Deposits & Stains	Sediment	Construction site erosion
	Oily	Sanitary wastewater
Vegetation	Excessive growth	Food product facilities, fertilizers, farming agricultural use
	Inhibited growth, stressed vegetation	High stormwater flows, beverage facilities, printing plants, metal product facilities, drug manufacturing, petroleum facilities, vehicle service facilities and automobile dealers
Pipe Benthic Growth	Brown	Elevated nutrient level, possibly from sewage or fertilizers
	Orange/Red	High iron and manganese concentration, not typically associated with illicit discharges
	Green	Elevated nutrient level, possibly from sewage or fertilizers
Damage to Outfall Structures	Concrete cracking	Industrial flows, chemicals
	Concrete spalling ¹	
	Peeling paint	
	Metal corrosion	

¹Concrete spalling: minor cracks and bulges in concrete caused by corrosion of the steel reinforcement inside the concrete.

6.3 What to Sample

If flow is present during a dry weather outfall inspection, a sample is collected and analyzed for the required permit parameters⁵ listed in **Table 6-2**. Field test kits or field instrumentation can be used for all parameters except indicator bacteria and any pollutants of concern. Field kits need to have appropriate detection limits and ranges. **Table 6-2** lists various field test kits and field instruments that can be used for outfall sampling associated with the 2016 MS4 Permit parameters for all waterbodies, other than indicator bacteria and any pollutants of concern.

Table 6-3 lists additional analyses for pollutants of concern in Barnstable based on the 2016 Integrated List of Waters which must be sampled for select waterbodies. This list requires review and update each time a new list is finalized in Massachusetts. Updates are maintained

⁵Other potentially useful parameters, although not required by the MS4 Permit, include **fluoride** (indicator of potable water sources in areas where water supplies are fluoridated), **potassium** (high levels may indicate the presence of sanitary wastewater), and **optical brighteners** (indicative of laundry detergents).

in **Appendix D** with the comprehensive SOP for Outfall Dry Weather Screening. Analytic procedures and user's manuals for field test kits and field instrumentation are also provided in **Appendix D**. All results are documented in **Appendix H**.

Table 6-2. Sampling Parameters and Analysis Methods for All Waterbodies

Analyte or Parameter	Instrumentation (Portable Meter)	Field Test Kit
Ammonia	CHEMetrics™ V-2000 Colorimeter Hach™ DR/890 Colorimeter Hach™ Pocket Colorimeter™ II	CHEMetrics™ K-1410 CHEMetrics™ K-1510 (series) Hach™ NI-SA Hach™ Ammonia Test Strips
Chlorine	CHEMetrics™ V-2000, K-2513 Hach™ Pocket Colorimeter™ II	NA
Conductivity	CHEMetrics™ I-1200 YSI Pro30 YSI EC300A Oakton 450	NA
Salinity	YSI Pro30 YSI EC300A Oakton 450	NA
Indicator Bacteria: <i>E.coli</i> (freshwater) or Enterococcus (saline water)	EPA certified laboratory Procedure (40 CFR § 136) Method 1103.1; 1603; Colilert 12 16, Colilert-18 12 15 16; mColiBlue-24 17	NA
Surfactants (Detergents)	CHEMetrics™ I-2017	CHEMetrics™ K-9400 and K-9404 Hach™ DE-2
Temperature	YSI Pro30 YSI EC300A Oakton 450	NA
Pollutants of Concern ⁶ :	EPA certified laboratory procedure (40 CFR § 136)	NA
See Table 6-3	See Table 6-3	

Samples for laboratory analysis must also be stored and preserved in accordance with procedures found in 40 CFR § 136. The SOP in **Appendix D** lists analytical methods, detection limits, hold times, and preservatives for laboratory analysis of dry weather sampling parameters.

⁶Where the discharge is directly into a water quality limited water or a water subject to an approved TMDL, samples must be analyzed for the pollutants of concern identified as the cause of the water quality impairment

Table 6-3. Additional Sampling Parameters for Discharges to Impaired

Sample Parameter	Impairment	Impaired Water		Method
BOD5	• DO	• Hamblin Pond • Lovells Pond	• Middle Pond • Mystic Lake	Laboratory Analysis: 360.1; 360.2
Dissolved oxygen	• DO	• Hamblin Pond • Lovells Pond	• Middle Pond • Mystic Lake	Field Meter or Laboratory Analysis: 365.1; 365.2; 365.3
Fecal Coliform	• Fecal coliform	• Bumps River • Centerville River • Cotuit Bay • Halls Creek • Hyannis Harbor • Hyannis Inner Harbor • Lewis Bay • Maraspin Creek • Mill Creek	• North Bay • Prince Cove • Santuit River • Seapuit River • Shoestring Bay • Snows Creek • Stewarts Creek • Barnstable Harbor • Red Lily Pond	Laboratory Analysis: 1680; 1681
Total Nitrogen	• Nitrogen • Estuarine Bioassessments	• Centerville River • Cotuit Bay • Hyannis Inner Harbor • Lewis Bay • Mill Creek • North Bay	• Popponesset Bay • Prince Cove • Shoestring Bay • West Bay • Barnstable Harbor	Test Kit (e.g., Hach Colorimeter Test Kit, total nitrogen (TNT)) or Laboratory Analysis: 351.1/351.2 + 353.2
Total Phosphorus	• Phosphorus • DO • Excess algal growth • Chlorophyll-a • Nutrient / Eutrophication Biological Indicators	• Hamblin Pond • Lovells Pond	• Middle Pond • Mystic Lake	Laboratory Analysis: 365.1; 365.2; 365.3; SM 4500-P-E
Total Suspended Solids (TSS)	• Secchi disk transparency	• Lovells Pond		Field Meter or Laboratory Analysis: 160.2; 180.1

6.3.1 Field Equipment

Table 6-4 lists field equipment commonly used for dry weather screening and sampling.

Table 6-4. Field Equipment – Dry Weather Outfall Screening and Sampling

Equipment	Use/Notes
Clipboard	For organization of field sheets and writing surface
Field Sheets	Field sheets for both dry weather inspection and Dry weather sampling should be available with extras
Chain of Custody Forms	To ensure proper handling of all samples
Pens/Pencils/Permanent Markers	For proper labeling
Nitrile Gloves	To protect the sampler as well as the sample from contamination
Flashlight/headlamp w/batteries	For looking in outfalls or manholes, helpful in early mornings as well
Cooler with Ice	For transporting samples to the laboratory
Digital Camera	For documenting field conditions at time of inspection
Personal Protective Equipment (PPE)	Reflective vest, Safety glasses and boots at a minimum
GPS Receiver	For taking spatial location data
Water Quality Sonde	If needed, for sampling conductivity, temperature, pH
Water Quality Meter	Hand held meter for testing for various water quality parameters such as ammonia, surfactants and chlorine
Test Kits	Have extra kits on hand to sample more outfalls than are anticipated to be screened in a single day
Label Tape	For labeling sample containers
Sample Containers	Make sure all sample containers are clean. Keep extra sample containers on hand at all times. Make sure there are proper sample containers for what is being sampled (i.e., bacteria sterile containers).
Pry Bar or Pick	For opening catch basins and manholes if necessary
Sandbags	For damming low flows in order to take samples
Small Mallet or Hammer	Helping to free stuck manhole and catch basin covers
Utility Knife	Multiple uses
Measuring Tape	Measuring distances and depth of flow
Safety Cones	Safety
Hand Sanitizer	Disinfectant/decontaminant
Zip Ties/Duct Tape	For making field repairs
Rubber Boots/Waders	For accessing shallow streams/areas
Sampling Pole/Dipper	For accessing hard to reach outfalls and manholes

6.4 Interpreting Outfall Sampling Results

Outfall analytical data from dry weather sampling can be used to help identify the major type or source of discharge. **Table 6-5** shows values identified by the U.S. EPA and the

Center for Watershed Protection as typical screening values for select parameters. These represent the typical concentration (or value) of each parameter expected to be found in stormwater. Screening values that exceed these benchmarks may indicate illicit discharges. All results are documented in **Appendix H**.

Table 6-5. Benchmark Field Measurements for Select Parameters

Parameter	Benchmark
Ammonia	>0.5 mg/L
Chlorine	>0.02 mg/L (detectable levels per the 2016 MS4 Permit)
Conductivity	>2,000 µS/cm
Salinity	Reference only, determine type of bacteria analysis
Indicator Bacteria ⁷ : <i>E.coli</i> <i>Enterococcus</i>	The geometric mean of the five most recent samples taken during the same bathing season shall not exceed: <i>E.coli</i> : 126 colonies per 100 ml and no single sample taken during the bathing season shall exceed 235 colonies per 100 ml <i>Enterococcus</i> : 33 colonies per 100 ml and no single sample taken during the bathing season shall exceed 61 colonies per 100 ml
Surfactants	>0.25 mg/L
Temperature	>83°F
Pollutants of Concern	>Applicable water quality criteria

Table 6-6 provides a summary on the types of discharge that may be encountered and follow-up actions to be performed. Additional information on next step actions is included in the SOPs in **Appendix E**.

Table 6-6. Outfall Discharge Designation and Follow-Up Action

Type	Description	Action
Obvious Discharge	Outfalls where there is an illicit discharge that do not require sample collection for confirmation (e.g., strong sewage odors, gray sewage water, toilet paper, etc.)	Full source investigation
Suspect Discharge	Flowing outfalls with: 1) high severity on one or more physical indicators and 2) ammonia >0.5 mg/L, surfactants >0.25 mg/L, bacteria >WQ criteria OR ammonia >0.5 mg/L, surfactants >0.25 mg/L, & detectable levels of chlorine	Full source investigation
Potential Discharge	Flowing or non-flowing outfalls with presence of two or more physical indicators	Intermittent flow source investigation
Unlikely Discharge	Non-flowing outfalls with no physical indicators of an illicit discharge	No further action

⁷ Massachusetts Water Quality Standards:
<http://www.mass.gov/eea/docs/dep/service/regulations/314cmr04.pdf>

6.5 Follow-up Ranking of Outfalls and Interconnections

The Town of Barnstable periodically updates and re-prioritizes outfall and interconnection rankings based on information gathered during dry weather outfall screening as additional data becomes available. Outfalls/interconnections where relevant information was found indicating sewer input to the MS4 or sampling results indicating sewer input are highly likely to contain illicit discharges from sanitary sources are ranked at the top of the High Priority Outfalls category for investigation. Other outfalls and interconnections may be re-ranked based on any new information from the dry weather screening. All results are documented in **Appendix H**.

7 Catchment Investigations

The 2016 MS4 Permit requires that investigations be performed for all MS4-owned outfall catchment areas regardless of whether flows are observed at the outfall. The catchment area represents the drainage area to the outfall. Catchment investigations must include: 1) a review of mapping and historic plans and records for each catchment to identify system vulnerability factors; 2) a manhole inspection methodology; and 3) procedures to isolate and confirm sources of illicit discharges.

This section outlines a systematic procedure to investigate outfall catchments. All data collected as part of the catchment investigations is recorded and reported in each annual report.

7.1 Dry Weather Key Junction Structure Inspections

In addition to the outfall screening discussed in Section 6, catchment investigations of key junction manholes must be performed during dry weather conditions. Several important terms related to the dry weather manhole inspection program are defined by the MS4 Permit as follows:

- **Junction Manhole** is a manhole or structure with two or more inlets accepting flow from two or more MS4 alignments. Manholes with inlets solely from private storm drains, individual catch basins, or both are not considered junction manholes for these purposes.
- **Key Junction Manholes** are those junction manholes/structures that can represent one or more junction manholes/structures without compromising adequate implementation of the illicit discharge program. Adequate implementation of the illicit discharge program would not be compromised if the exclusion of a particular junction manhole/structure as a key junction manhole/structure would not affect the permittee's ability to determine the possible presence of an upstream illicit discharge. A permittee may exclude a junction manhole/structure located upstream from another located in the immediate vicinity or that is serving a drainage alignment with no potential for illicit connections.

Key junction manholes are inventoried by identifying all junction manholes/structures with two or more inlets and then eliminating those that were located in the immediate vicinity of the outfall, in the immediate vicinity of another key junction manhole and those that only received flow from one or two catch basins with no potential for illicit connections. For all catchments identified for investigation, field crews systematically inspect key junction manholes for evidence of illicit discharges during dry weather. A stormwater key junction manhole screening standard operating procedure (SOP) and checklist is included in **Appendix F**. Screening procedures should be implemented beginning with High Priority Outfalls and ending with Low Priority Outfalls. Problem Outfalls do not require screening, rather proceed right to source investigations (refer to Section 6.0).

7.1.1 When to Inspect

Visual inspections for illicit discharges must occur during dry weather conditions. Dry weather conditions are defined as a minimum of 24 consecutive hours with less than 0.10 inches of rainfall and no significant snow melt is occurring. MS4s are designed to only carry stormwater runoff. If a flow exists at a discharge point during the dry weather inspections, it is identified as a potential illicit discharge.

7.1.2 What to Look For: Physical Characteristics

Each identified key junction manhole must be opened and inspected systematically for visual and olfactory evidence of illicit connections (e.g., excrement, toilet paper, gray filamentous bacterial growth, or sanitary products present). The same observation made for outfalls can also be applied to key junction manhole investigations. Refer to **Table 6-1** in Section 6.0 for parameters and what they mean.

Key junction manholes within the same catchment area can be inspected working from the outfall upstream or working from the most upstream key junction manholes down towards the outfall.

7.1.3 What to Sample

If flow is observed in any manhole, a sample must be collected and analyzed for:

- Ammonia
- Chlorine
- Surfactants

Field kits or instrumentation can be used for these analyses. All results are documented in **Appendix H**.

7.1.4 Interpreting Key Junction Inspection Results

Where sampling results or visual or olfactory evidence indicate potential illicit discharges or SSOs (**Table 7-1**), the area draining to the junction manhole must be flagged for further upstream investigation to isolate and confirm sources of illicit discharges in accordance with Section 8.0. Key junction and subsequent manhole investigations proceed until the location of suspected illicit discharges or SSOs can be isolated to a pipe segment between two manholes.

Screening procedures should be implemented beginning with High Priority Catchments and ending with Low Priority Catchments. Problem Outfalls do not require screening and should instead proceed right to source investigations (refer to Section 8). A comprehensive SOP for Key Junction Manhole Dry Weather Screening with checklist and forms are included in **Appendix F**. All results are documented in **Appendix H**.

Table 7-1. Key Junction Discharge Designation and Follow-Up Action

Type	Description	Action
Obvious Discharge	Key junction manholes where there is an illicit discharge that do not require sample collection for confirmation (e.g., strong sewage odors, gray sewage water, toilet paper, etc.)	Full source investigation
Suspect Discharge	Flowing key junction manholes with: 1) high severity on one or more physical indicators and 2) ammonia >0.5 mg/L, surfactants >0.25 mg/L, & detectable levels of chlorine	Full source investigation
Potential Discharge	Flowing or non-flowing key junction manholes with presence of two or more physical indicators	Intermittent flow source investigation
Unlikely Discharge	Non-flowing key junction manholes with no physical indicators of an illicit discharge	No further action

7.2 System Vulnerability Factors and Wet Weather Sampling

Wet weather screening and sampling is required where System Vulnerability Factors (SVFs) exist within a catchment area, including:

- History of SSOs, including but not limited to, those resulting from wet weather, high water table, or fat/oil/grease blockages;
- Common or twin-invert manholes serving storm and sanitary sewer alignments;
- Common trench construction serving both storm and sanitary sewer alignments;
- Crossings of storm and sanitary sewer alignments where the sanitary system is shallower than the storm drain system;
- Sanitary sewer alignments known or suspected to have been constructed in regular surcharging, customer back-ups, or frequent customer complaints;
- Areas formerly served by combined sewer systems;
- Sanitary sewer infrastructure defects such as leaking service laterals, cracked, broken, or offset sanitary infrastructure, directly piped connections between storm drain and sanitary sewer infrastructure, or other vulnerability factors identified through Inflow/Infiltration Analyses, Sanitary Sewer Evaluation Surveys, or other infrastructure investigations.

EPA recommends that the following SVFs also be considered:

- Sewer pump/lift stations, siphons, or known sanitary sewer restriction where power/equipment failures or blockages could readily result in SSOs;
- Any sanitary sewer and storm drain infrastructure greater than 40 years old;
- Widespread code-required septic system upgrades required at property transfers or history of multiple Board of Health actions addressing widespread septic system failures (indicative of inadequate soils, water table separation, or other physical constraints of the area rather than poor owner maintenance).

Wet weather sampling will be performed in accordance with the SOP included in **Appendix G**. The SVF inventory (**Appendix C**) will be updated as new information becomes available and included in the annual report.

7.2.1 When to Sample: Wet Weather Conditions

Where a minimum of one System Vulnerability Factor (SVF) is identified based on previous information or the catchment investigation, one wet weather screening and sampling event shall be performed at the outlet. A comprehensive SOP for Catchment Wet Weather Sampling with checklist and forms are included in **Appendix G**, however inspections will generally proceed as follows:

1. At least one wet weather sample will be collected at the outfall for the same parameters required during dry weather screening.
2. Wet weather sampling will occur during or after a storm event of sufficient depth or intensity to produce a stormwater discharge at the outfall. There is no specific rainfall amount that will trigger sampling, although minimum storm event intensities that are likely to trigger sanitary sewer interconnections are preferred. To the extent feasible, sampling should occur during the spring (March through June) when groundwater levels are relatively high.
3. If wet weather outfall sampling indicates a potential illicit discharge, then additional wet weather source sampling will be performed, as warranted, or source isolation and confirmation procedures will be followed as described in Section 8.
4. If wet weather outfall sampling does not identify evidence of illicit discharges, and no evidence of an illicit discharge is found during dry weather manhole inspections, catchment investigations will be considered complete.

7.2.2 What to Sample: Wet Weather Conditions

Samples collected during wet weather investigations should be analyzed for:

- Ammonia
- Chlorine
- Conductivity
- Salinity
- E.coli (freshwater receiving water) or enterococcus (saline or brackish receiving water)
- Surfactants (such as MBAS)
- Temperature
- Pollutants of concern – where the discharge is directly into a water quality limited water or a water subject to an approved TMDL, the sample shall be analyzed for the pollutant(s) of concern identified as the cause of the impairment

All analyses, with the exception of indicator bacteria can be performed with field test kits or field instrumentation. Refer to **Table 6-6** in Section 6.0 for additional details on acceptable concentrations that can be used to assess potential illicit discharges from Barnstable’s MS4. All results will be documented in **Appendix H**.

7.2.3 Interpreting Wet Weather Sampling Results

Wet weather sampling results can be compared to the benchmark values in **Table 6-5**. Screening values that exceed these benchmarks may be indicative of pollution and/or illicit discharges that warrant further investigation. In the case of wet weather sampling, low to moderate levels of bacteria may be associated with wildlife or domestic animal feces, rather than an illicit connection. Similarly, slight exceedances of ammonia benchmarks may also be caused by natural conditions. However, evidence of surfactants and/or chlorine are more likely to be attributed to man-made sources. All data collected during preparation of the IDDE Plan and throughout the catchment investigation process, including information on the surrounding land uses, visual and olfactory observations during dry and wet weather screening, age and history of surrounding septic tanks and/or sewer, storm characteristics, and water quality data should be considered in determining the potential presence of an illicit discharge and the steps for investigation.

Exceedances of one or more parameters by substantial amounts (e.g., an order of magnitude) may be indicative of an illicit discharge and a follow-up round of wet weather sampling should be performed. If additional samples deliver similar results, additional manhole sampling should be completed during wet weather in an attempt to “bracket” a potential source to confirm the presence or absence of an illicit discharge. All results will be documented in **Appendix H**.

8 Source Investigations

Once an illicit discharge is identified at an outfall or manhole, further investigation is necessary to identify the specific point where the illicit discharge comes from (source). The objective of a source investigation is to trace the path of an illicit discharge from the outfall or manhole to the upstream source.

The following methods may be used in isolating and confirming the source of illicit discharges

- Field Reviews;
- Sandbagging;
- Smoke Testing;
- Dye Testing;
- CCTV/Video Inspections; and
- Optical Brightener Monitoring

Public notification is an important aspect of a detailed source investigation program. Prior to smoke testing, dye testing, or TV inspections, the Department of Public Works notifies property owners in the affected area. These methods are described in more detail below.

8.1 Field Reviews

Reviewing the drainage system and land uses within contributing catchment areas is the first and perhaps the most efficient method for identifying the source of an illicit discharge. It is important for field crews to observe the land use and activities around the upgradient drainage system to determine if there are any obvious sources of the illicit discharge, as a quick review of nearby land uses and activities may reveal the source immediately. In addition, field crews can simply follow the non-stormwater discharge if it is flowing by tracing the drainage system such as manholes and connecting drainage pipes (refer to SOP in **Appendix E**). Sampling these upgradient connections may also indicate where the source is located. However, some cases may require additional methods, such as sandbagging, dye testing, smoke testing, or television inspection as discussed below, if a flow cannot be traced due to blind connections or complicated drainage networks.

8.2 Sandbagging

This technique can be particularly useful when attempting to isolate intermittent illicit discharges or those with very little perceptible flow. The technique involves placing sandbags or similar barriers (e.g., caulking, weirs/plates, or other temporary barriers) within manholes to form a temporary dam that collects any intermittent flows that may occur. Sandbags are typically left in place for 48 hours, and should only be installed when dry weather is forecast. If flow has collected behind the sandbags/barriers after 48 hours it can be assessed using visual observations or by sampling. If no flow collects behind the sandbag, the upstream pipe network can be ruled out as a source of the intermittent discharge. Finding

appropriate durations of dry weather and the need for multiple trips to each manhole makes this method both time-consuming and somewhat limiting.

8.3 Smoke Testing

Smoke testing involves injecting non-toxic smoke into drain lines and noting the emergence of smoke from sanitary sewer vents in illegally connected buildings or from cracks and leaks in the system itself. Typically, a smoke bomb or smoke generator is used to inject the smoke into the system at a catch basin or manhole and air is then forced through the system. Test personnel are placed in areas where there are suspected illegal connections or cracks/leaks, noting any escape of smoke (indicating an illicit connection or damaged storm drain infrastructure).

To be most effective, pipes may need to be plugged to prevent smoke from easily escaping through manholes, catch basins, or daylight areas. If a cross connection exists, smoke should appear from the building's sanitary sewer vent at the roof. The smoke should not affect residents since nearly all sanitary sewer systems have a trap to prevent odors from backing up into the house; however, residents with respiratory conditions may need to be monitored or evacuated from the area of testing to ensure safety during testing. In many cases, smoke testing should only be used once an unknown pipe is identified. The individual pipe can be plugged and filled with smoke while workers look for signs of smoke at nearby buildings or facilities.

It is important when using this technique to make proper notifications to area residents and business owners as well as local police and fire departments. This notification presents a good opportunity to involve the public as observers during the smoke test and to educate local residents about stormwater, allowable non-stormwater discharges and illicit discharges. Providing the public with an opportunity to participate in the illicit discharge source investigation promotes IDDE efforts and awareness throughout town.

If the initial test of the storm drain system is unsuccessful then a more thorough smoke-test of the sanitary sewer lines can also be performed. Note that buildings that do not emit smoke during sanitary sewer smoke tests may have problem connections and may also have sewer gas venting inside, which is hazardous.

8.4 Dye Testing

Dye testing involves flushing non-toxic dye into plumbing fixtures such as toilets, showers, and sinks and observing nearby storm drains and sewer manholes as well as stormwater outfalls for the presence of the dye. Similar to smoke testing, it is important to inform local residents and business owners. Police, fire, and local public health staff should also be notified prior to testing in preparation of responding to citizen phone calls concerning the dye and its presence in local surface waters.

A team of two or more people is needed to perform dye testing (ideally, all with two-way radios). One person is inside the building, while the others are stationed at the appropriate

storm sewer and sanitary sewer manholes (which should be opened) and/or outfalls. The person inside the building adds dye into a plumbing fixture (i.e., toilet or sink) and runs a sufficient amount of water to move the dye through the plumbing system. The person inside the building then radios to the outside crew that the dye has been dropped, and the outside crew watches for the dye in the storm sewer and sanitary sewer, recording the presence or absence of the dye.

The test can be relatively quick (about 30 minutes per test), effective (results are usually definitive), and inexpensive. Dye testing is best used when the likely source of an illicit discharge has been narrowed down to a few specific houses or businesses. Successful Tips for dye testing are provided in **Table 8-1**.

8.5 CCTV/Video Inspection

Another method of source isolation involves the use of mobile video cameras that are guided remotely through stormwater drain lines to observe possible illicit discharges. IDDE program staff can review the videos and note any visible illicit discharges. While this tool is both effective and usually definitive, it can be costly and time consuming when compared to other source isolation techniques.

8.6 Optical Brightener Monitoring

Optical brighteners are fluorescent dyes that are used in detergents and paper products to enhance their appearance. The presence of optical brighteners in surface waters or dry weather discharges suggests there is a possible illicit discharge or insufficient removal through adsorption in nearby septic systems or wastewater treatment. Optical brightener monitoring can be done in two ways. The most common, and least expensive, methodology involves placing a cotton pad in a wire cage and securing it in a pipe, manhole, catch basin, or inlet to capture intermittent dry weather flows. The pad is retrieved at a later date and placed under UV light to determine the presence/absence of brighteners during the monitoring period. A second methodology uses handheld fluorometers to detect optical brighteners in water samples collected from outfalls or ambient surface waters. Use of a fluorometer, while more quantitative, is typically more costly and is not as effective at isolating intermittent discharges as other source isolation techniques.

Table 8-1. Tips for Successful Dye Testing

Dye Selection

- Green and liquid dyes are the easiest to see.
- Dye test strips can be a good alternative for residential or some commercial applications. (Liquid can leave a permanent stain).
- Check the sanitary sewer before using dyes to get a “base color.” In some cases, (e.g., a print shop with a permitted discharge to the sanitary sewer), the sewage may have an existing color that would mask a dye.
- Choose two dye colors, and alternate between them when testing multiple fixtures.

Selecting Fixtures to Test

- Check the plumbing plan for the site to isolate fixtures that are separately connected.
- For industrial facilities, check most floor drains (these are often misdirected).
- For plumbing fixtures, test a representative fixture (e.g., a bathroom sink).
- Test some locations separately (e.g., washing machines and floor drains), which may be misdirected.
- If conducting dye investigations on multiple floors, start from the basement and work your way up.
- At all fixtures, make sure to flush with plenty of water to ensure that the dye moves through the system.

Selecting a Sewer Manhole for Observations

- Pick the closest manhole possible to make observations (typically a sewer lateral).
- If this is not possible, choose the nearest downstream manhole.

Communications Between Crew Members

- The individual conducting the dye testing calls in to the field person to report the color dye used, and when it is dropped into the system.
- The field person then calls back when dye is observed in the manhole.
- If dye is not observed (e.g., after two separate flushes have occurred), dye testing is halted until the dye appears.

Locating Missing Dye

- The investigation is not complete until the dye is found. Some reasons for dye not appearing include:
- The building is actually hooked up to a septic system.
- The sewer line is clogged.
- There is a leak in the sewer line or lateral pipe.

Source: Center for Watershed Protection. Illicit Discharge Detection and Elimination, A Guidance Manual for Program Development and Technical Assessments. October 2004.

9 Illicit Discharge Removal

When the specific source of an illicit discharge is identified, the Town of Barnstable exercises its authority as necessary to require its removal. The Department of Public Works collects relevant documentation and records to pursue illicit discharge removal through voluntary elimination or legal enforcement.

9.1 Removal Options

9.1.1 Voluntary Elimination

The voluntary elimination of illicit discharges is strongly encouraged. Through voluntary elimination, the responsible party of an illicit discharge can be contacted directly and informed about the incident. A responsible Town official should make this contact after an illicit discharge has been identified and verified. When a responsible party is contacted, the following information should be provided:

- Details on the identification and verification process;
- Information on the actions that should be implemented to correct the problem and the schedule for performing them; and
- Potential support and incentives that the Town can offer as a result of the voluntary approach.

This approach is the quickest and provides an opportunity for the responsible party to correct the problem in a cost-effective manner, versus a legal enforcement obligation, which is discussed below.

9.1.2 Legal Enforcement

Legal enforcement action may be necessary to completely eliminate illicit discharges in the Town, particularly those that have significant cost implications. Barnstable is in the process of updating current bylaws to will better establish legal authority for enforcement of IDDE requirements as required under the 2016 MS4 Permit and will be provided in the SWMP Plan. This regulatory mechanism in part will allow for enforcement of the regulations, orders, violation notices, and enforcement orders, and may pursue civil and criminal remedies for such violations.

9.2 Reporting

All illicit discharge information should be recorded on the Illicit Discharge Tracking Form for each location, with overall actions recorded in the Illicit Discharge Log, both provided in **Appendix H**. The illicit discharge must be removed within sixty (60) days of its confirmation where possible, otherwise a schedule will be established for its elimination with dates and schedules identified in the MS4 annual report. The annual report will also include the status of IDDE investigation and removal activities including the following information for each confirmed source:

- The location of the discharge and its source(s);
- A description of the discharge;
- The method of discovery;
- Date of discovery;
- Date of elimination, mitigation or enforcement action OR planned corrective measures and a schedule for completing the illicit discharge removal; and
- Estimate of the volume of flow removed.

9.3 Confirmatory Outfall Screening

Confirmatory outfall screening will be completed within one year of removal of all identified illicit discharges within a catchment area and include confirmatory outfall or interconnection screening. The confirmatory screening will be conducted in dry weather unless System Vulnerability Factors have been identified, in which case both dry weather and wet weather confirmatory screening will be conducted. Procedures will follow those outlined earlier in this chapter and in the appendices of this IDDE Plan. If confirmatory screening indicates evidence of additional illicit discharges, the catchment will be scheduled for additional investigation.

9.4 Ongoing Screening

Upon completion of all catchment investigations and illicit discharge removal and confirmation (if necessary), each outfall or interconnection will be re-prioritized for screening, as needed, and scheduled for ongoing screening once every five years. Ongoing screening will consist of dry weather screening and sampling consistent with the procedures described in Section 6 of this plan. Ongoing wet weather screening and sampling will also be conducted at outfalls where wet weather screening was required due to System Vulnerability Factors and will be conducted in accordance with the procedures described in Section 7.2. All sampling results will be reported in the annual report.

9.5 IDDE Prevention

Preventing future illicit discharges is also critically important. Prevention of illicit discharges is achieved through education, outreach, and advocacy. Education and advocacy programs that identify where and when possible illicit discharges and connections occur are good long-term prevention activities. The following activities can be used to help prevent illicit discharges to the drainage system:

- Integrate IDDE information into public education and outreach components;
- Encourage awareness and promote stewardship of the storm drain system in neighborhoods, emphasizing the cause and effect relationship between non-stormwater inputs to the drainage system and water quality of receiving waters;
- Utilize the annual IDDE program evaluation results to promote and support the program throughout the Town; and
- Use the Town's website and provide a phone number for citizens to report suspected illicit discharges.

10 Training

Annual IDDE training is made available to all employees involved in the IDDE program. This training at a minimum includes information on how to identify illicit discharges and may also include additional training specific to the functions of particular personnel and their function within the framework of the IDDE program. Training records are maintained in the IDDE Employee Training Record provided in **Appendix I**. The frequency and type of training are included in the annual report.

11 Progress Reporting

11.1 Program Activity and Timeline

A summary of the required IDDE activities and timelines are provided below:

<u>Activity</u>	<u>Timeline</u>
Sanitary Sewer Overflow Inventory	Complete by June 30, 2019
Initial Catchment Ranking	Complete by June 30, 2019
Mapping:	
• Outfalls and Interconnections	Complete by June 30, 2020
• Initial Catchment Delineation	Complete by June 30, 2020
• Remaining Mapping	Complete by June 30, 2028
Dry Weather Outfall Inspections	Complete by June 30, 2021
Catchment Investigations:	
• Problem Catchments	Begin by July 1, 2020 Complete by June 30, 2025
• All w/Potential Illicit Discharges	Complete by June 30, 2025
• All Outfalls Complete	Complete by June 30, 2028
Source Investigation	As soon as sampling results indicating an illicit discharge are obtained and evaluated
Source Elimination	Within 60 days of its identification or, if not possible, in accordance with schedule established by the Town (refer to Section 9)
Confirmatory Samples	Within 1 year of illicit discharge elimination.
Follow-Up Screening	Reprioritize and resample all outfalls for weather conditions as per the first round within 5 years
Employee Training	Perform annually
Recordkeeping	At all times for all activities

11.2 Annual Recordkeeping

The progress and success of the IDDE program is evaluated on an annual basis. The evaluation is documented in the annual report and includes the following indicators of program progress:

- Number of illicit discharges identified and removed;
- Number and percent of total outfall catchments served by the MS4 evaluated using the catchment investigation procedure;
- Number of dry weather outfall inspections/screenings;
- Number of wet weather outfall inspections/sampling event;
- Number of enforcement notices issued;
- All dry weather and wet weather screening and sampling results;
- Estimate of the volume of sewage removed, as applicable; and
- Number of employees trained annually.

The success of the IDDE program is measured by the IDDE activities completed within the required permit timelines.

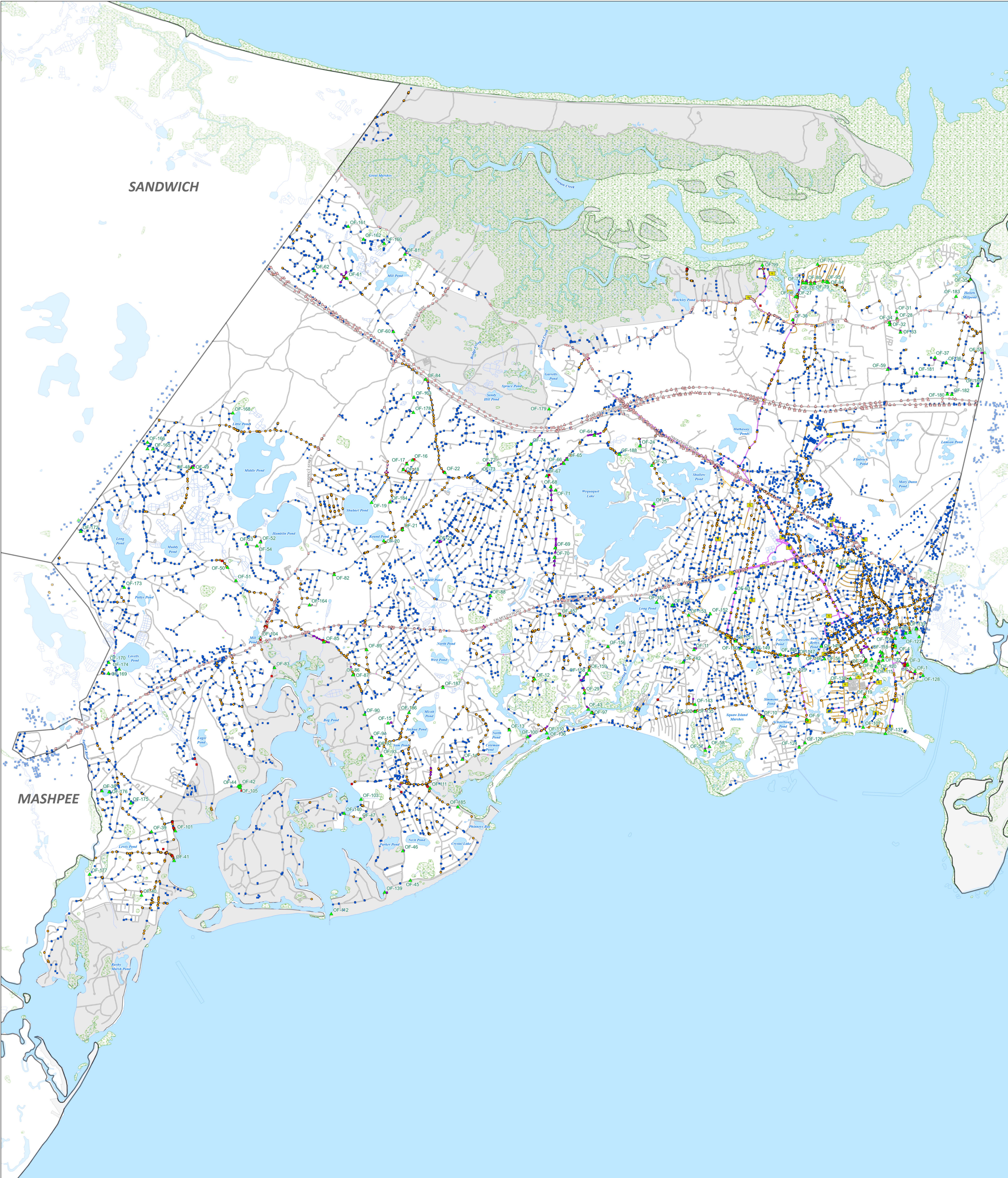
Appendix A

Storm System Mapping

Status of Stormwater System Mapping

Requirement Summary	Status
Phase I – Must be Complete by July 1, 2020	
1. Outfalls and receiving waters	Complete
2. Open channel conveyances	Complete (updates ongoing)
3. Interconnections with other MS4s	Ongoing
4. Municipally owned structural BMPs	Complete
5. Waterbody names and impairments	Complete
6. Initial catchment delineations by topography	Complete
Phase II – Must be Complete by July 1, 2028	
1. Outfalls with spatial accuracy +/-30 feet	Complete (updates ongoing)
2. Pipe connectivity	Complete (updates ongoing)
3. Manholes	Complete
4. Catch basins	Complete
5. Refined catchment delineations	Not started
6. Municipal sanitary system	Moderately Complete
7. Municipal combined sewer system	Not Applicable

Additional outfalls may be found while completing the field inspections and should be added to the drainage map, and ranking and monitored.



Legend

- ▲ Outfalls

■ Stormwater BMP

● Drainage Manhole

● Catch Basin connected to Outfall

● Catch Basin

✦ Interconnections

~ Swale

~ Storm Water Gravity Drain

— Culvert

▲ DOT Outfall

▲ DOT Manhole

▲ DOT Catch Basin
- Sewer Data:

■ Pump Station

— Sewer Pipe

— Sewer Force Main

— Sewer Gravity

— Sewer Vacuum

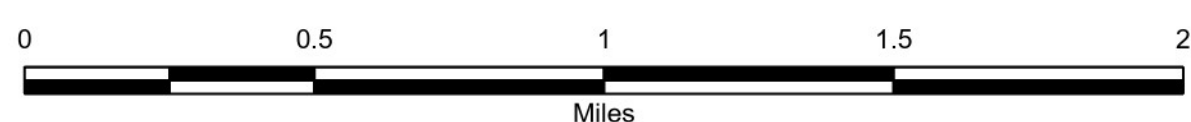
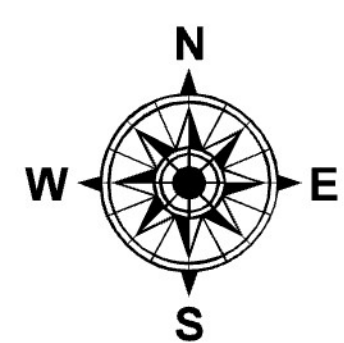
— Roads

— Lake, Pond, Reservoir

— Wetland, Marsh, Swamp

— Stream, Brook

— Non-Urban Area



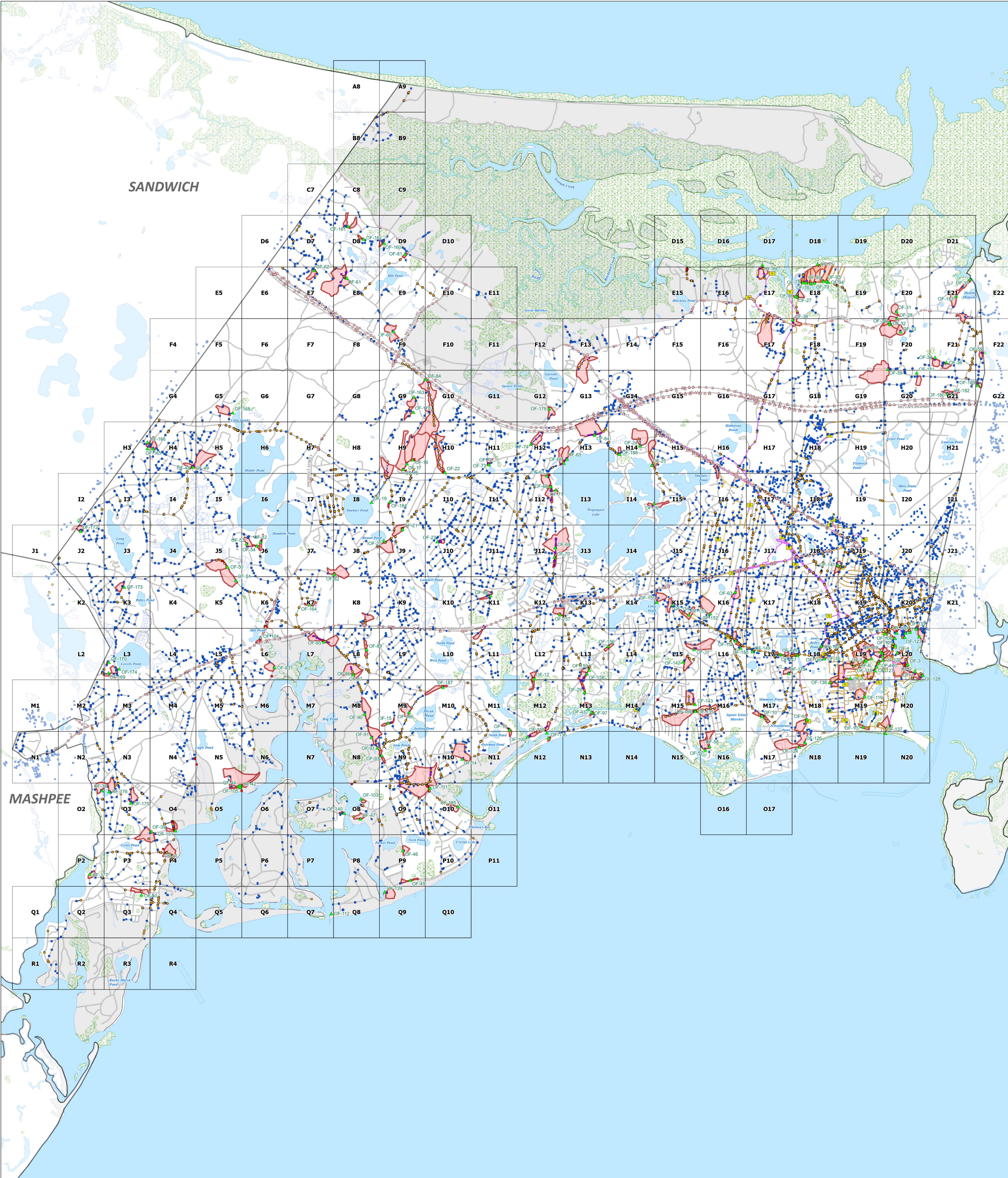
Stormwater Infrastructure Map

Barnstable, MA

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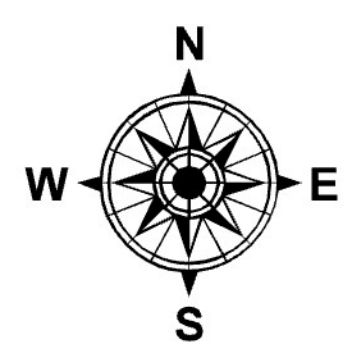


Data Sources: CEI, MassGIS, Town of Barnstable



Legend

- ▲ Outfalls
 - Stormwater BMP
 - Drainage Manhole
 - Catch Basin connected to Outfall
 - Catch Basin
 - ✦ Interconnections
 - Swale
 - Storm Water Gravity Drain
 - Culvert
 - Catchment
 - ▲ DOT Outfall
 - DOT Manhole
 - DOT Catch Basin
- Sewer Data:
- Pump Station
 - Sewer Pipe
 - Sewer Force Main
 - Sewer Gravity
 - Sewer Vacuum
 - Roads
 - Lake, Pond, Reservoir
 - Wetland, Marsh, Swamp
 - Stream, Brook
 - Non-Urban Area



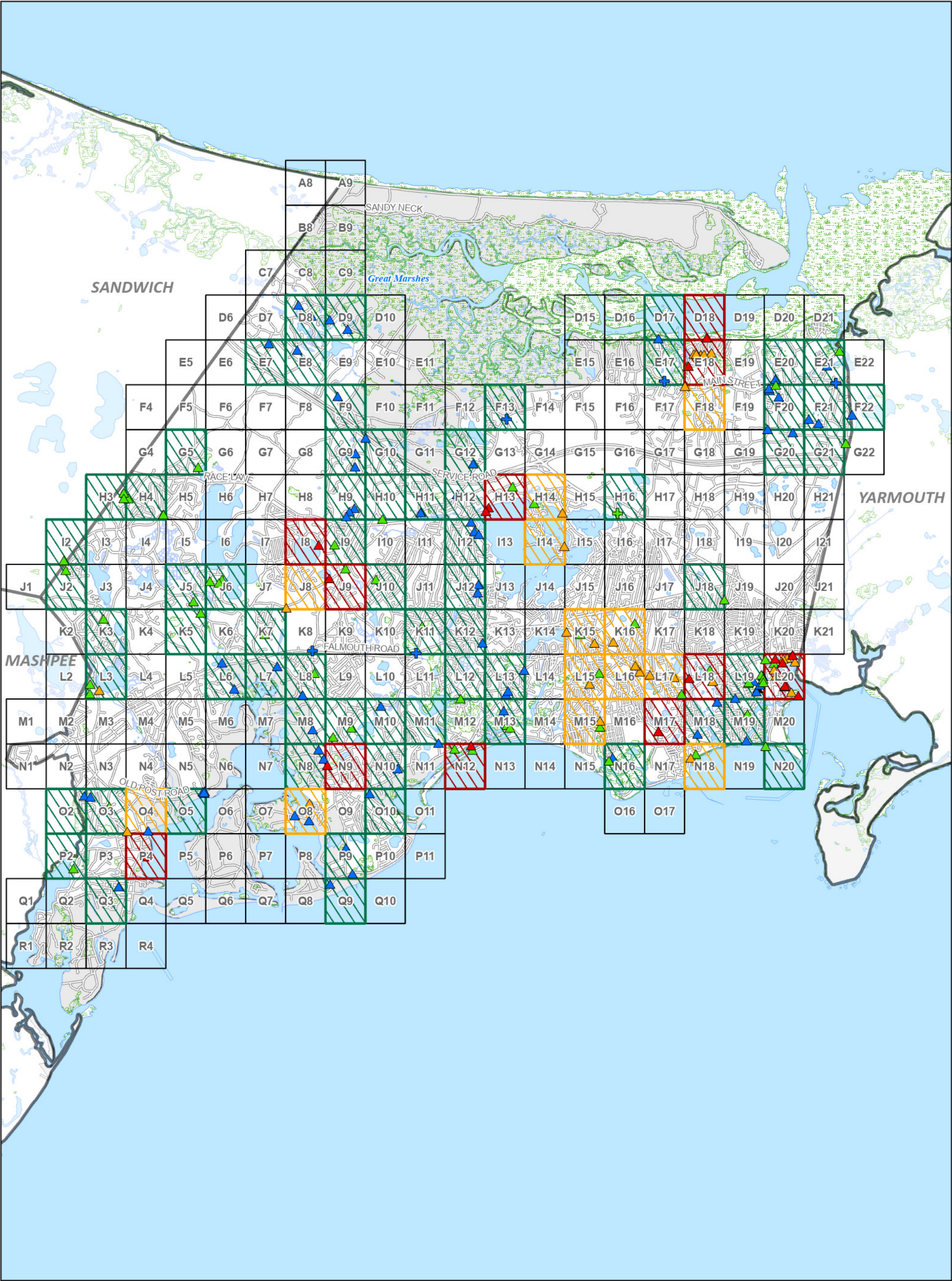
Stormwater Master Tile Map

Barnstable, MA

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Data Sources: CEI, MassGIS, Town of Barnstable



Legend

Prioritized Outfalls:

- 3 or higher
- 2
- 1
- Low Priority Outfall
- Excluded Outfall

Prioritized Interconnections:

- 1
 - Low Priority Interconnection
- Prioritized Tiles:
- High
 - Medium

- Low
- Lake, Pond, Reservoir
- Wetland, Marsh, Swamp
- Stream, Brook
- Non-Urban Area



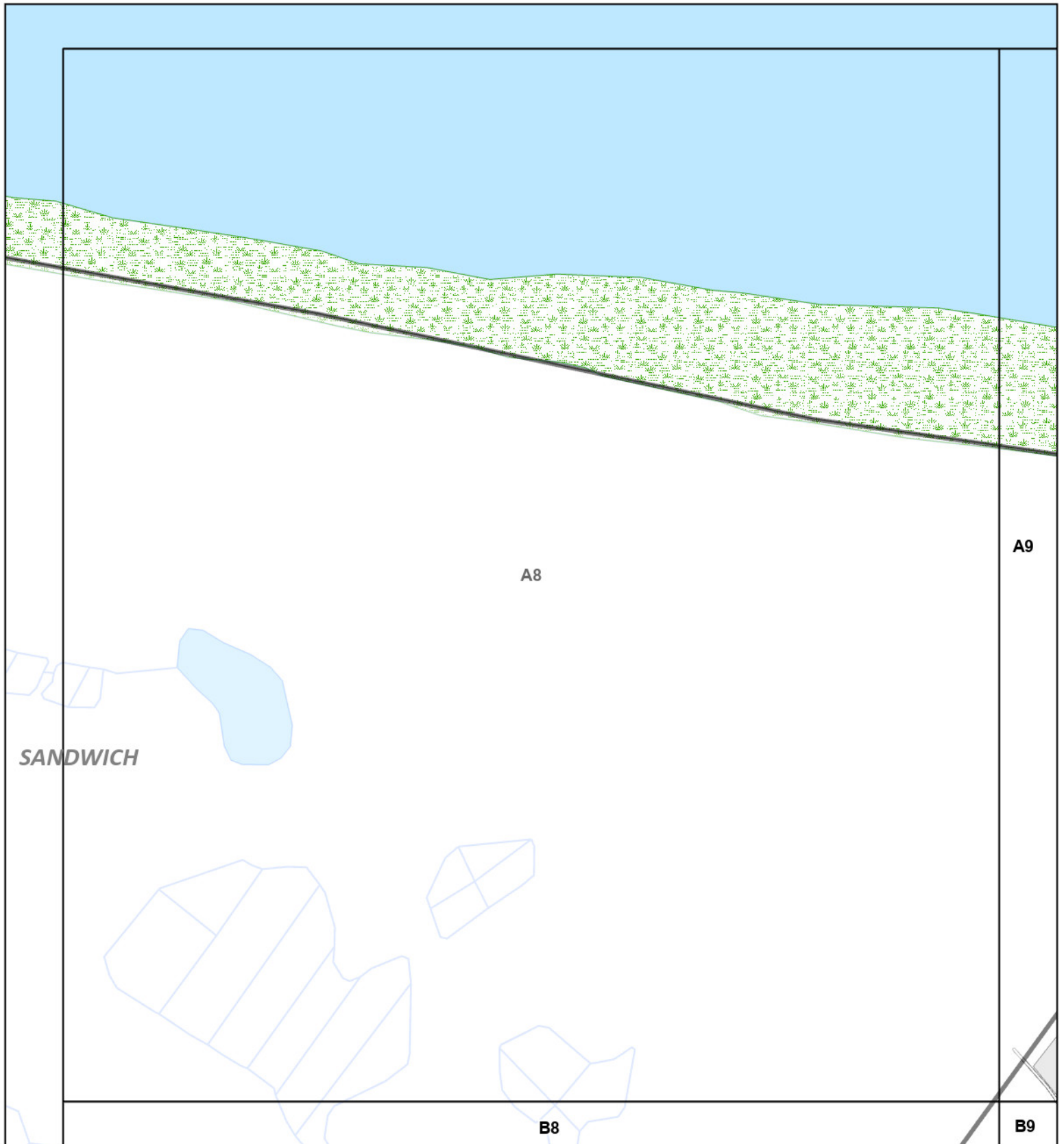
Stormwater Map with
Prioritized Outfalls and Areas
Barnstable, MA



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Note: Higher priority outfalls are ranked 1-5 with 3 or more being the highest priority

Data Sources: MassGIS, Town of Barnstable, CEI



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| ▲ Outfalls | ● DOT Manhole |
| ■ Catch Basin | ■ DOT Catch Basin |
| ● Drainage Manhole | — Storm Water Gravity Drain |
| ■ Stormwater BMP | — Swale |
| ★ Key Drainage Manhole | — Catchment |
| ✚ Interconnections | — Non-Urban Area |
| ▲ DOT Outfall | |

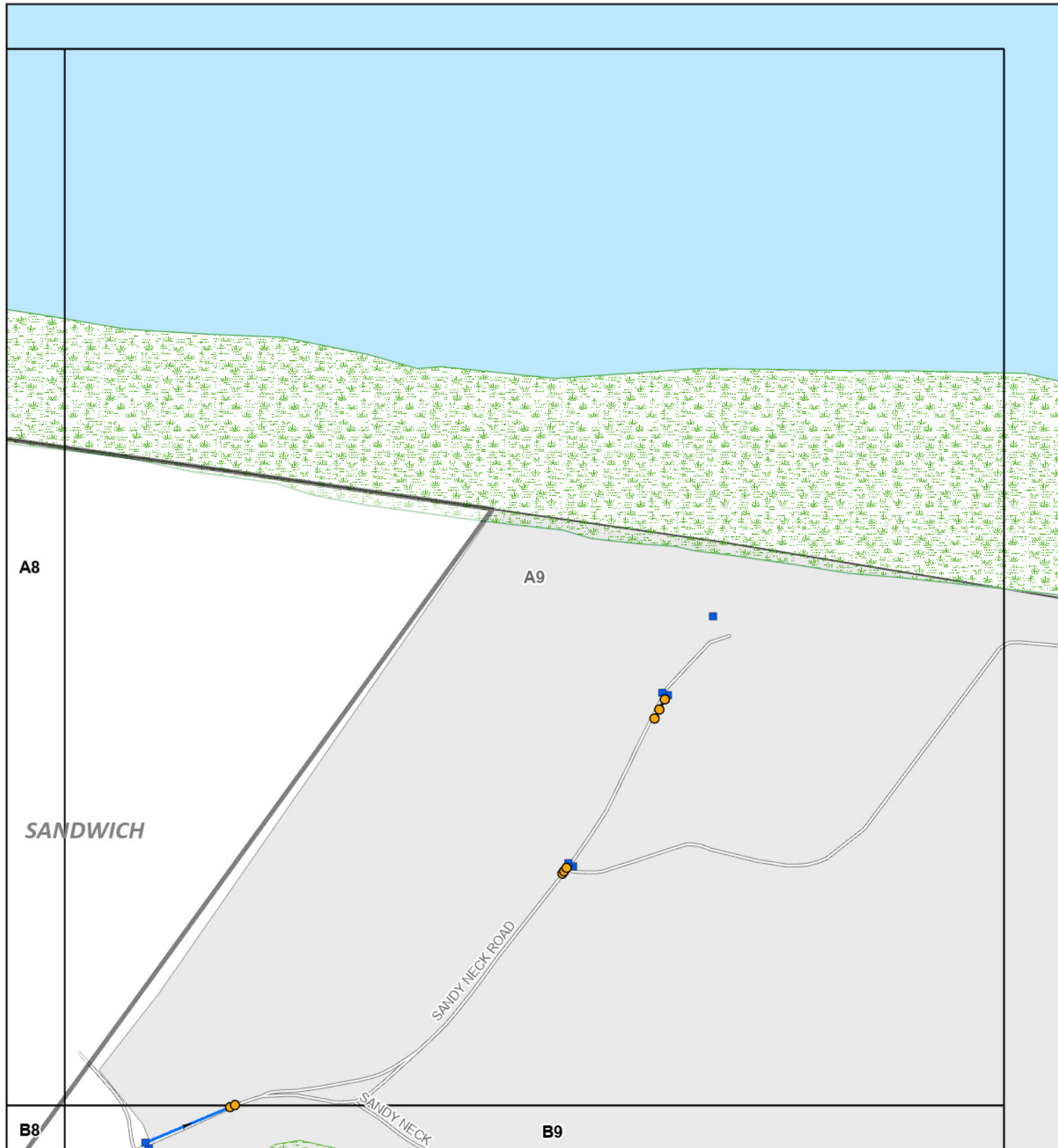
Stormwater Infrastructure Map Barnstable, MA

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| ▲ Outfalls | ○ DOT Manhole |
| ■ Catch Basin | ■ DOT Catch Basin |
| ● Drainage Manhole | — Storm Water Gravity Drain |
| ■ Stormwater BMP | — Swale |
| ★ Key Drainage Manhole | — Catchment |
| ✚ Interconnections | — Non-Urban Area |
| △ DOT Outfall | |

Stormwater Infrastructure Map Barnstable, MA

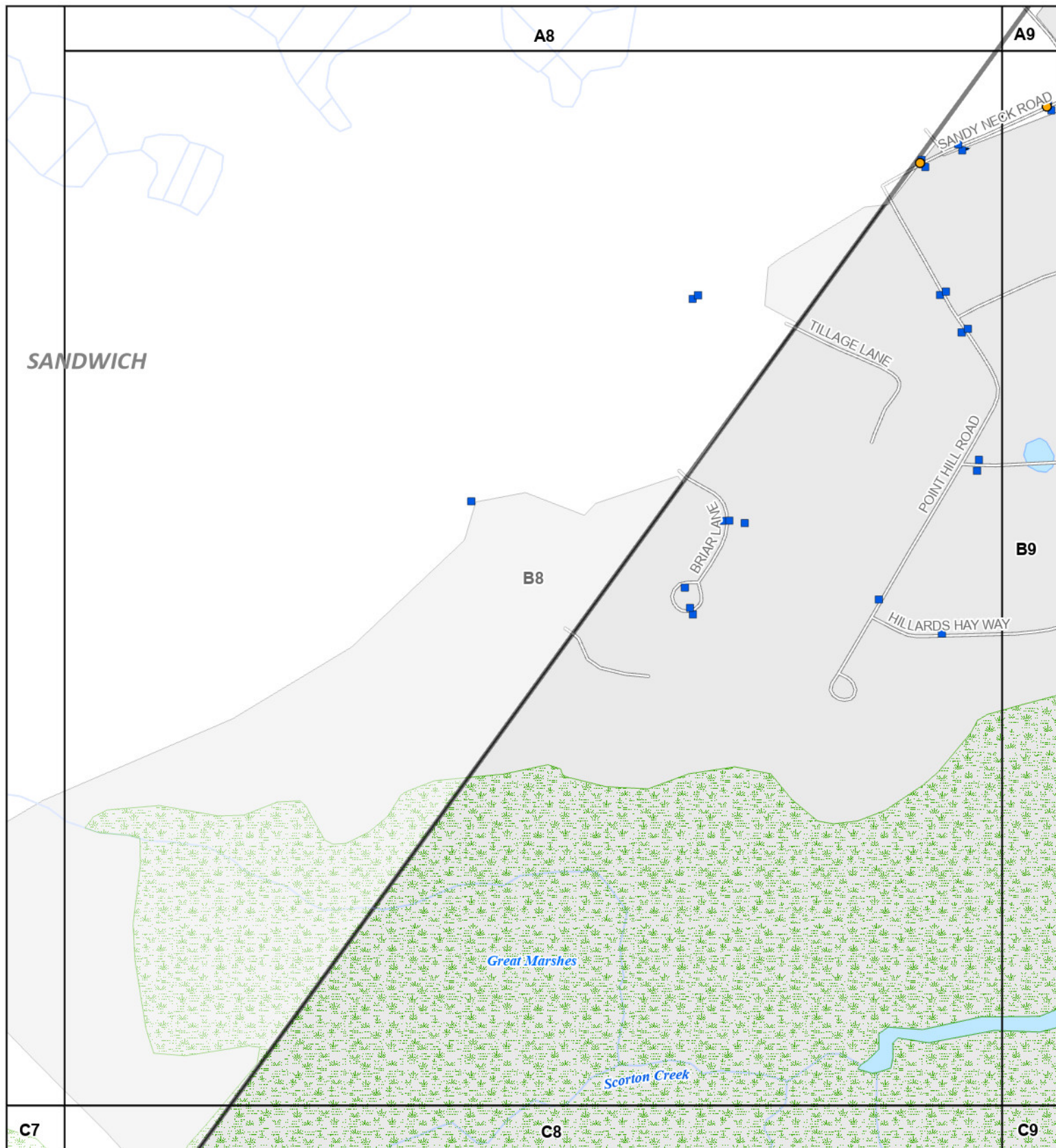
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| ▲ Outfalls | ○ DOT Manhole |
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| ● Drainage Manhole | — Storm Water Gravity Drain |
| ■ Stormwater BMP | ~ Swale |
| ★ Key Drainage Manhole | — Catchment |
| ✚ Interconnections | — Non-Urban Area |
| ▲ DOT Outfall | |

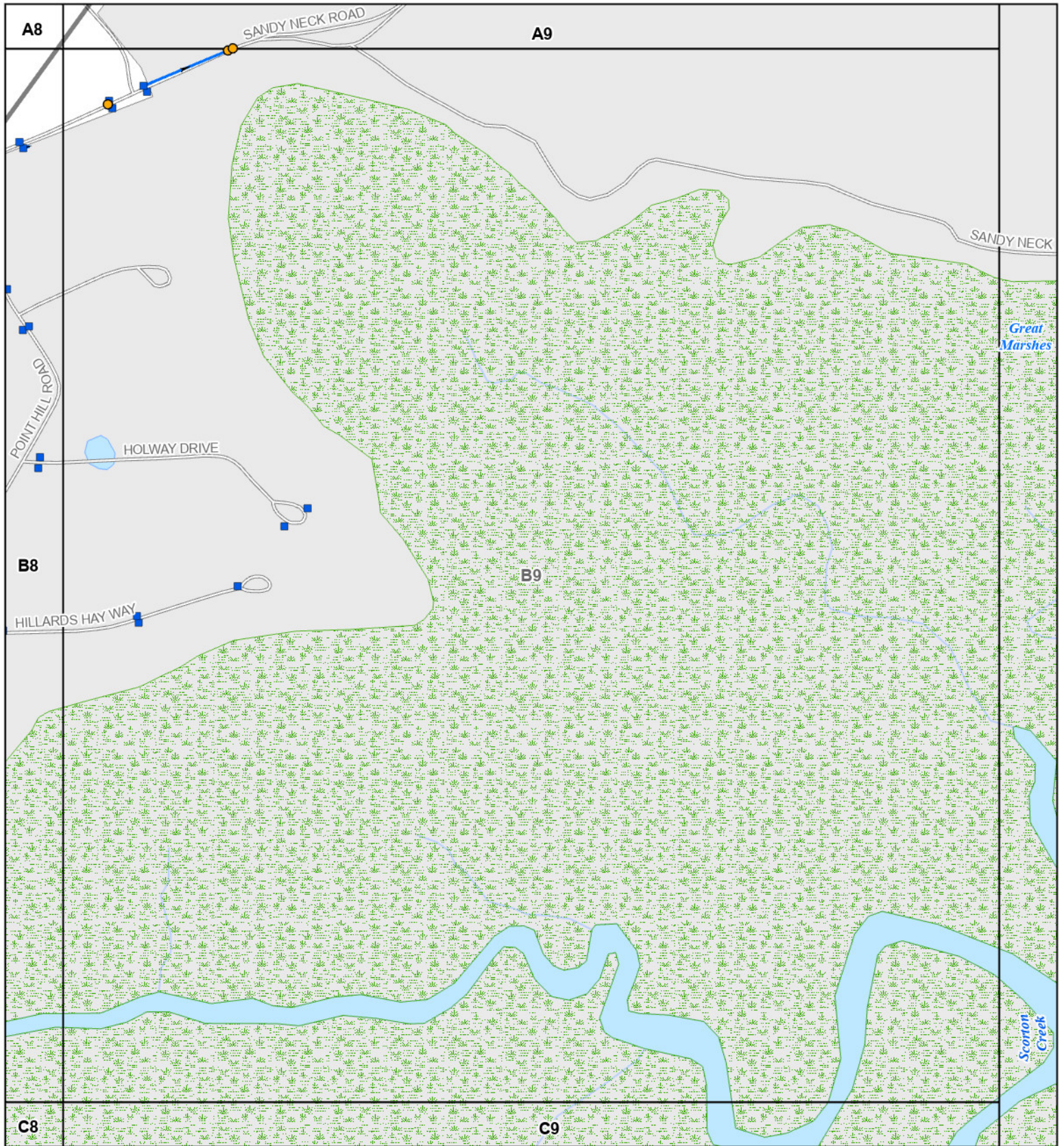
Stormwater Infrastructure Map Barnstable, MA

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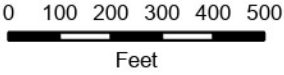


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Stormwater Infrastructure
Map
Barnstable, MA

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| ▲ Outfalls | ● DOT Manhole |
| ■ Catch Basin | ■ DOT Catch Basin |
| ● Drainage Manhole | — Storm Water Gravity Drain |
| ■ Stormwater BMP | — Swale |
| ★ Key Drainage Manhole | — Catchment |
| ✚ Interconnections | — Non-Urban Area |
| ▲ DOT Outfall | |

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FIELDSTONE ROAD

HIGH STREET

LISA LANE

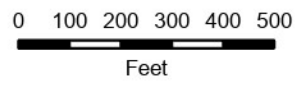
PERCIVAL DRIVE

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| ■ Catch Basin | ■ DOT Catch Basin |
| ● Drainage Manhole | — Storm Water Gravity Drain |
| ■ Stormwater BMP | — Swale |
| ★ Key Drainage Manhole | — Catchment |
| ✚ Interconnections | — Non-Urban Area |
| ▲ DOT Outfall | |

Stormwater Infrastructure Map Barnstable, MA

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Creek

KALWEIT DRIVE

SCORTON HILL ROAD

MAIN STREET

PAANANEN CIRCLE

Great Marshes

C8

C9

C7

LISA LANE

HIGH STREET

WILLIAMS PATH

SMITH CREEK LANE

PERCIVAL DRIVE

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| ▲ Outfalls | ○ DOT Manhole |
| ■ Catch Basin | ■ DOT Catch Basin |
| ● Drainage Manhole | — Storm Water Gravity Drain |
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| ★ Key Drainage Manhole | — Catchment |
| ✚ Interconnections | — Non-Urban Area |
| ▲ DOT Outfall | |

**Stormwater Infrastructure
Map
Barnstable, MA**

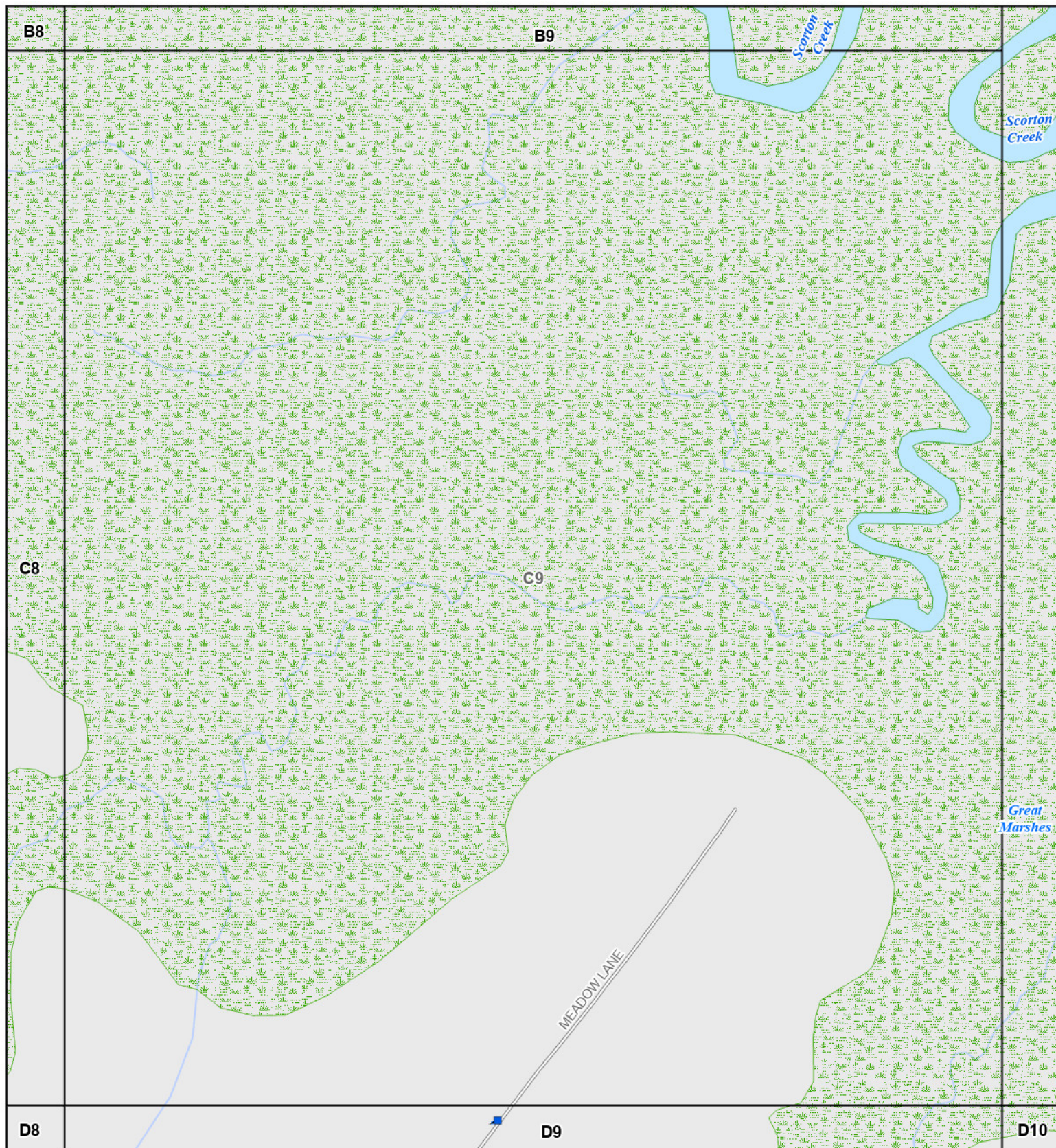
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| ★ Key Drainage Manhole | — Catchment |
| ✚ Interconnections | — Non-Urban Area |
| ▲ DOT Outfall | |

Stormwater Infrastructure Map Barnstable, MA

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ABEGALE SNOW ROAD

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| ■ Catch Basin | ■ DOT Catch Basin |
| ● Drainage Manhole | — Storm Water Gravity Drain |
| ■ Stormwater BMP | — Swale |
| ★ Key Drainage Manhole | — Catchment |
| ✚ Interconnections | — Non-Urban Area |
| △ DOT Outfall | |

Stormwater Infrastructure Map Barnstable, MA

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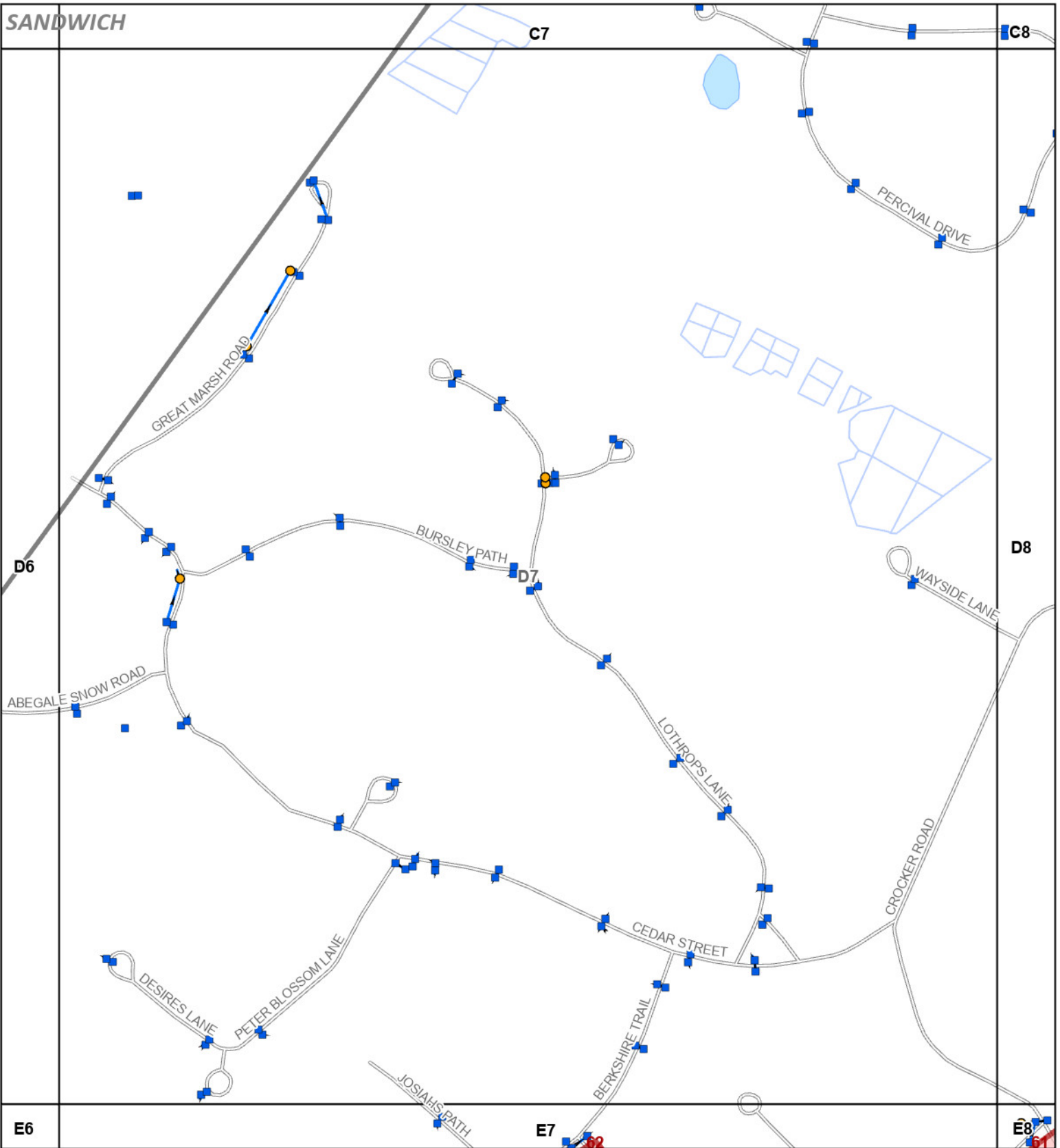
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| ■ Stormwater BMP | — Swale |
| ★ Key Drainage Manhole | — Catchment |
| ✚ Interconnections | — Non-Urban Area |
| ▲ DOT Outfall | |

Stormwater Infrastructure Map Barnstable, MA

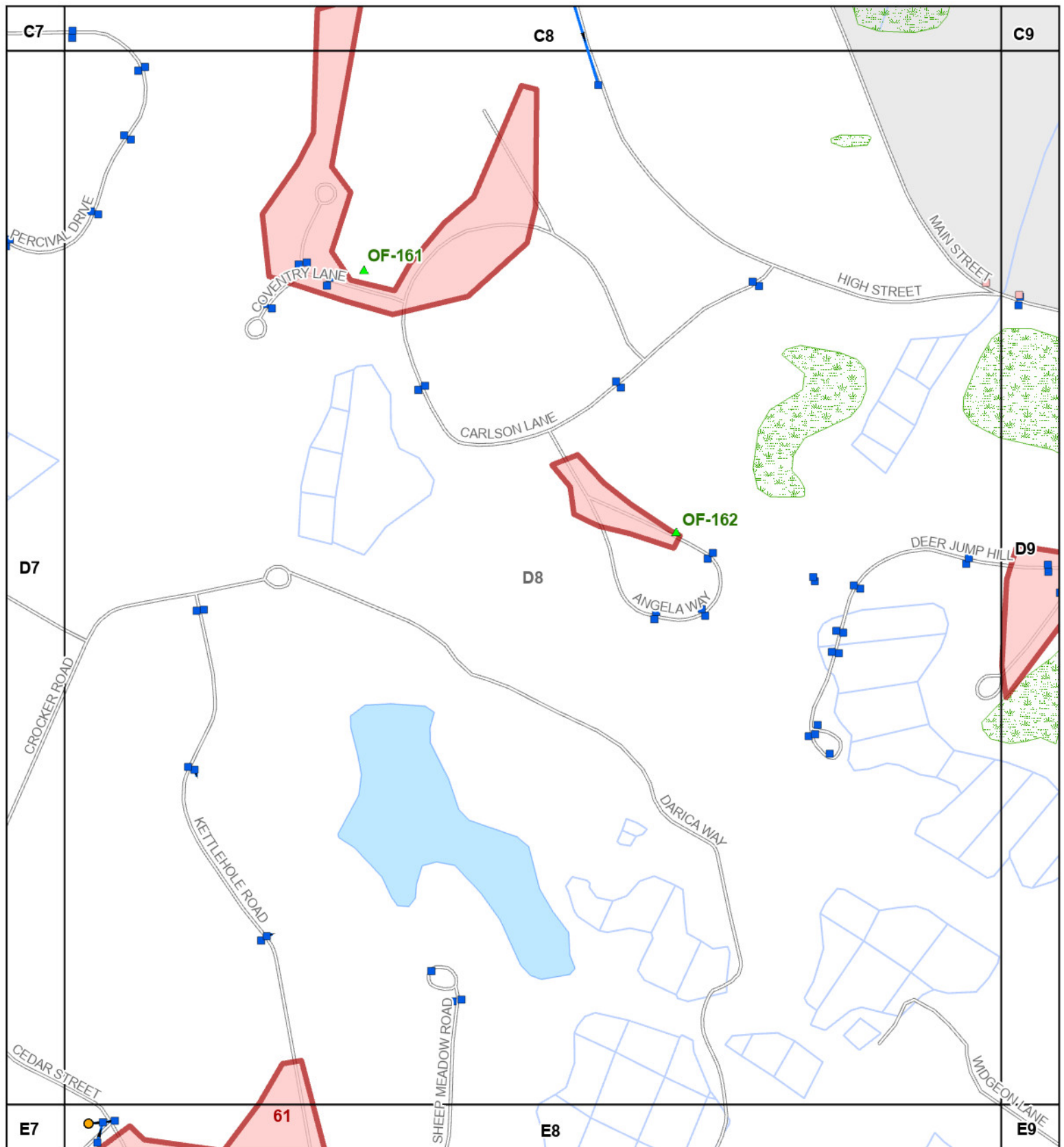
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| ● Drainage Manhole | — Storm Water Gravity Drain |
| ■ Stormwater BMP | — Swale |
| ★ Key Drainage Manhole | — Catchment |
| ✚ Interconnections | — Non-Urban Area |
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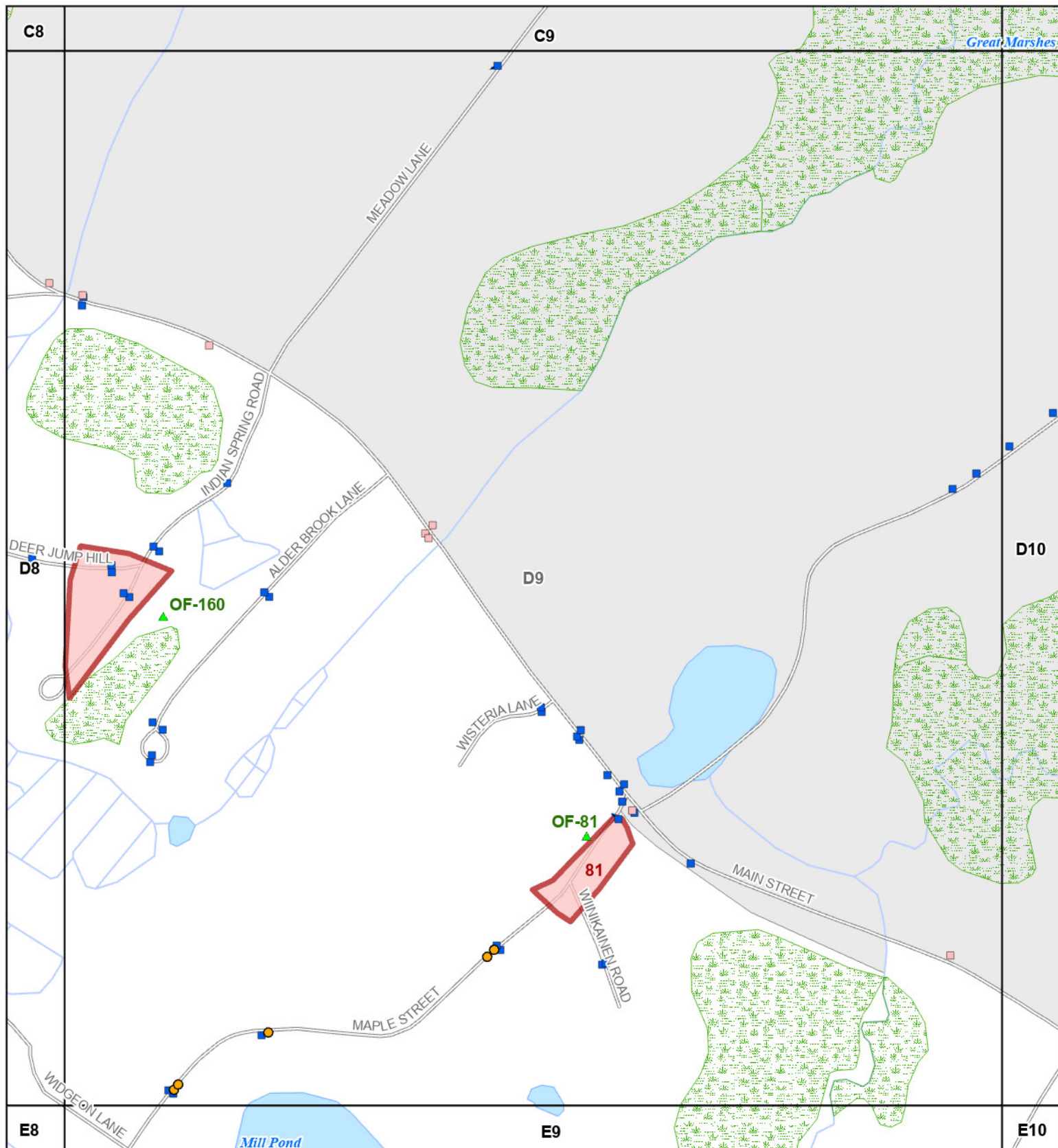
Stormwater Infrastructure Map Barnstable, MA

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| ● Drainage Manhole | — Storm Water Gravity Drain |
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| ★ Key Drainage Manhole | — Catchment |
| ✚ Interconnections | — Non-Urban Area |
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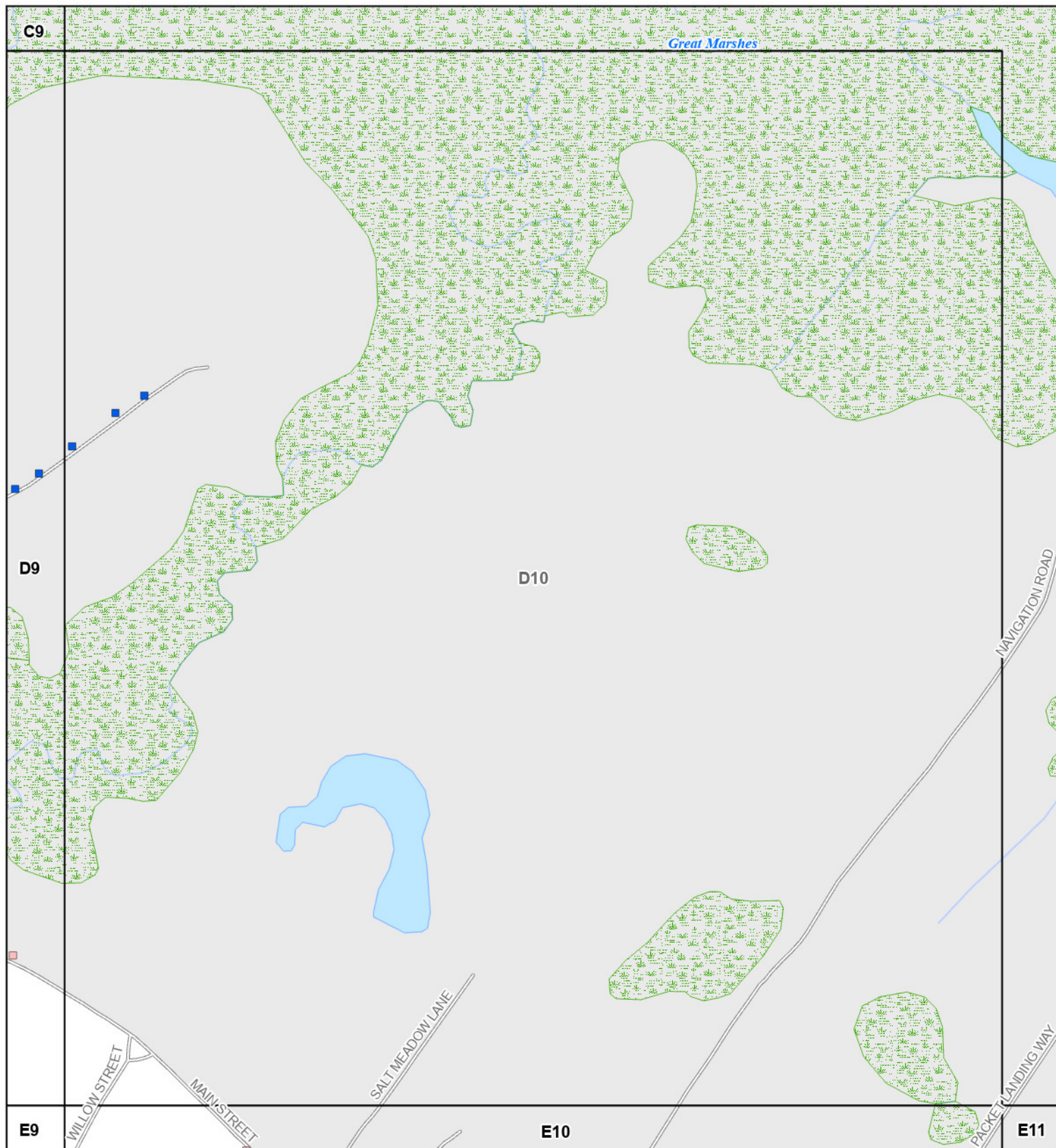
Stormwater Infrastructure Map Barnstable, MA

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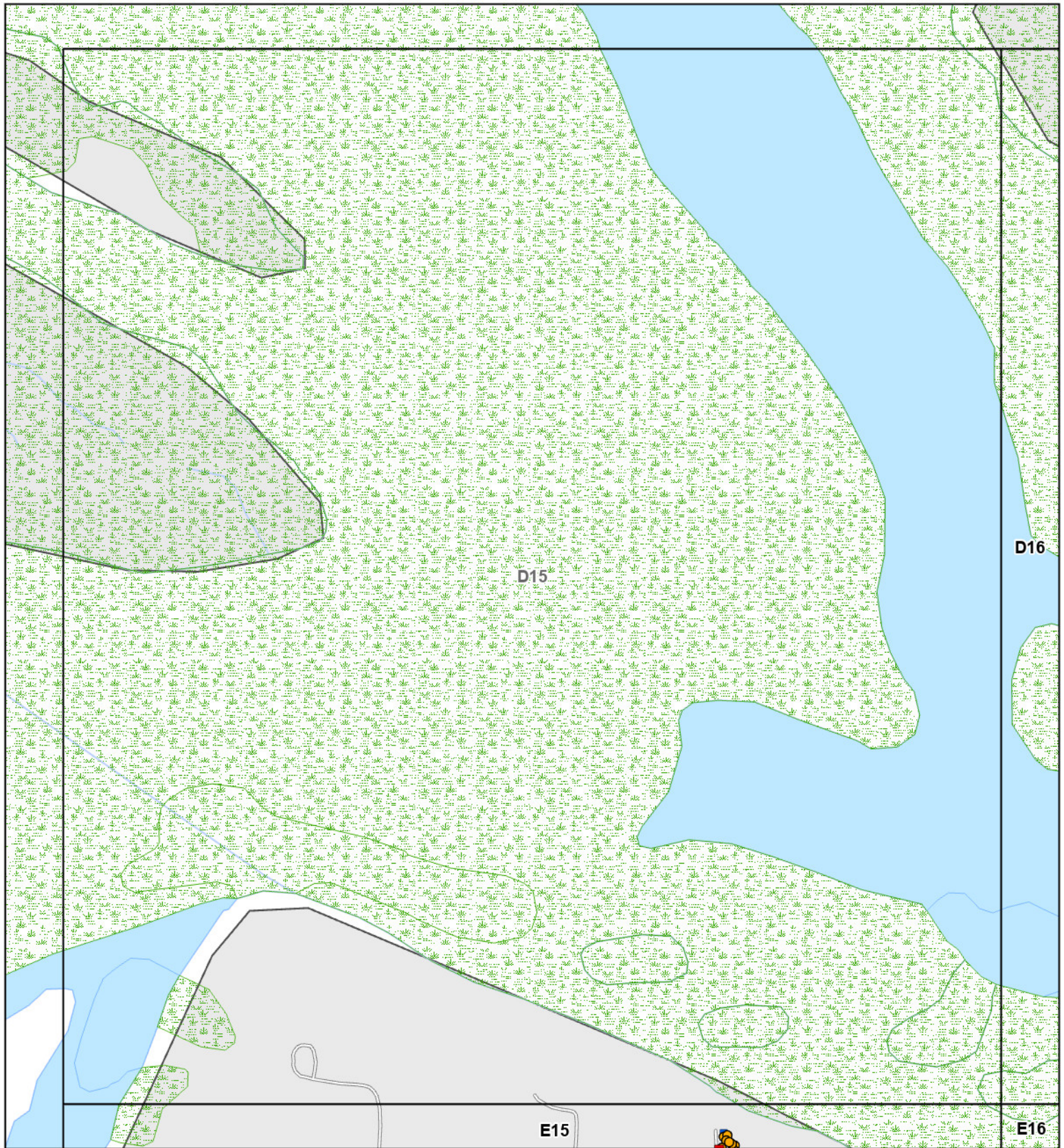
Stormwater Infrastructure Map Barnstable, MA

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| ● Drainage Manhole | — Storm Water Gravity Drain |
| ■ Stormwater BMP | — Swale |
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| ✚ Interconnections | — Non-Urban Area |
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Stormwater Infrastructure Map Barnstable, MA

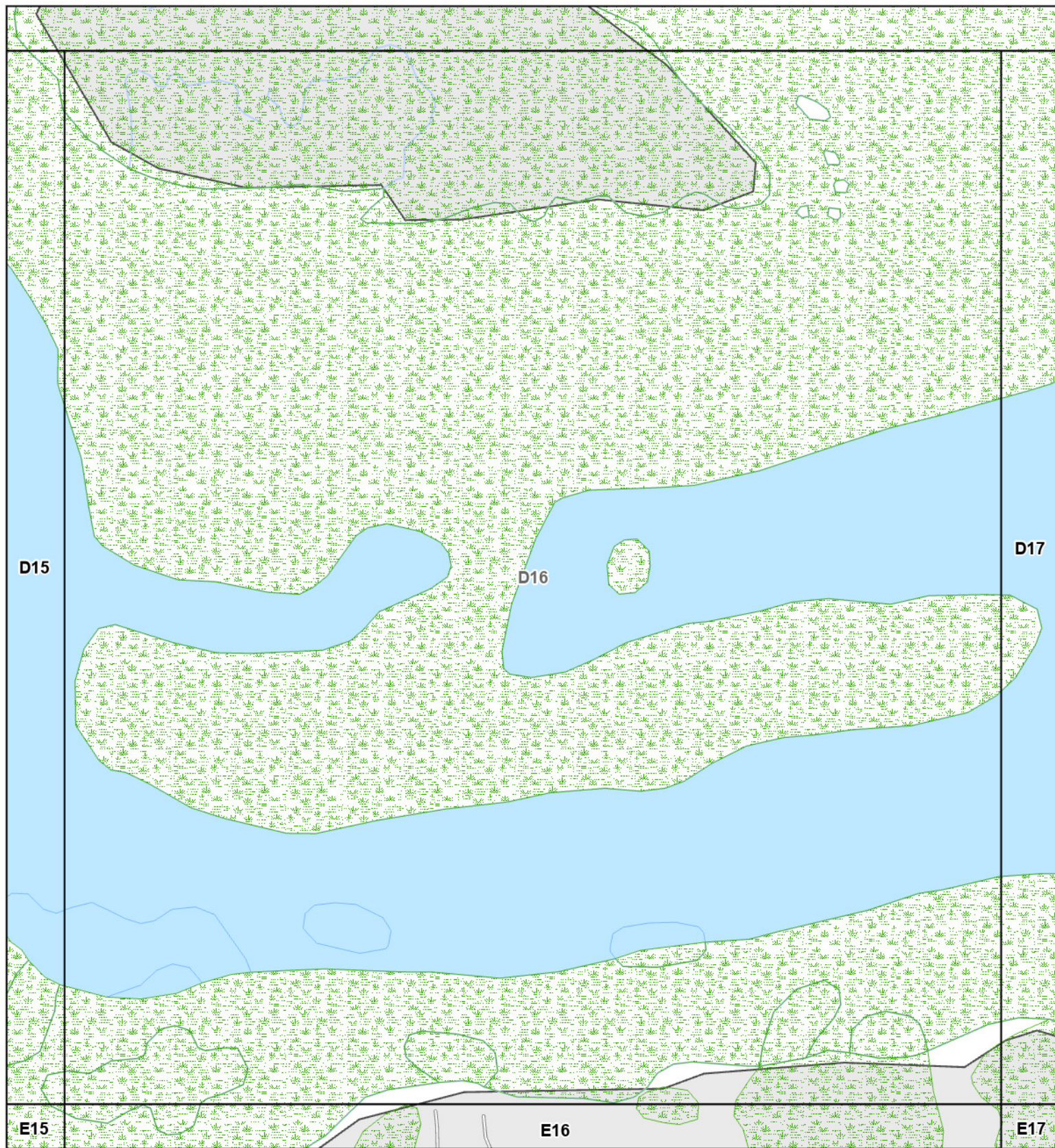
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| ● Drainage Manhole | — Storm Water Gravity Drain |
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| ★ Key Drainage Manhole | — Catchment |
| ✚ Interconnections | — Non-Urban Area |
| ▲ DOT Outfall | |

Stormwater Infrastructure **Map** **Barnstable, MA**

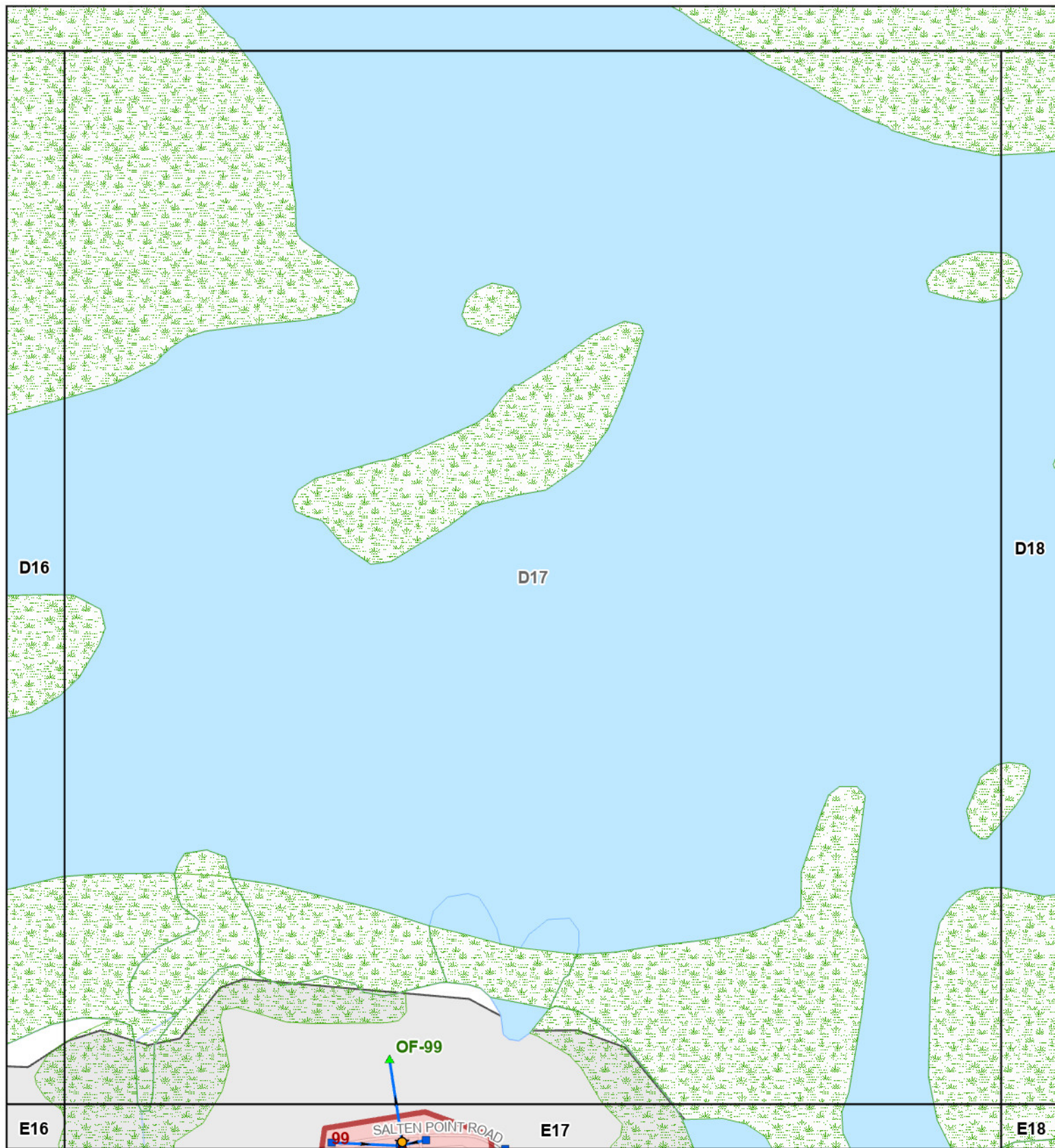
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| ● Drainage Manhole | — Storm Water Gravity Drain |
| ■ Stormwater BMP | — Swale |
| ★ Key Drainage Manhole | — Catchment |
| ✚ Interconnections | — Non-Urban Area |
| ▲ DOT Outfall | |

Stormwater Infrastructure Map Barnstable, MA

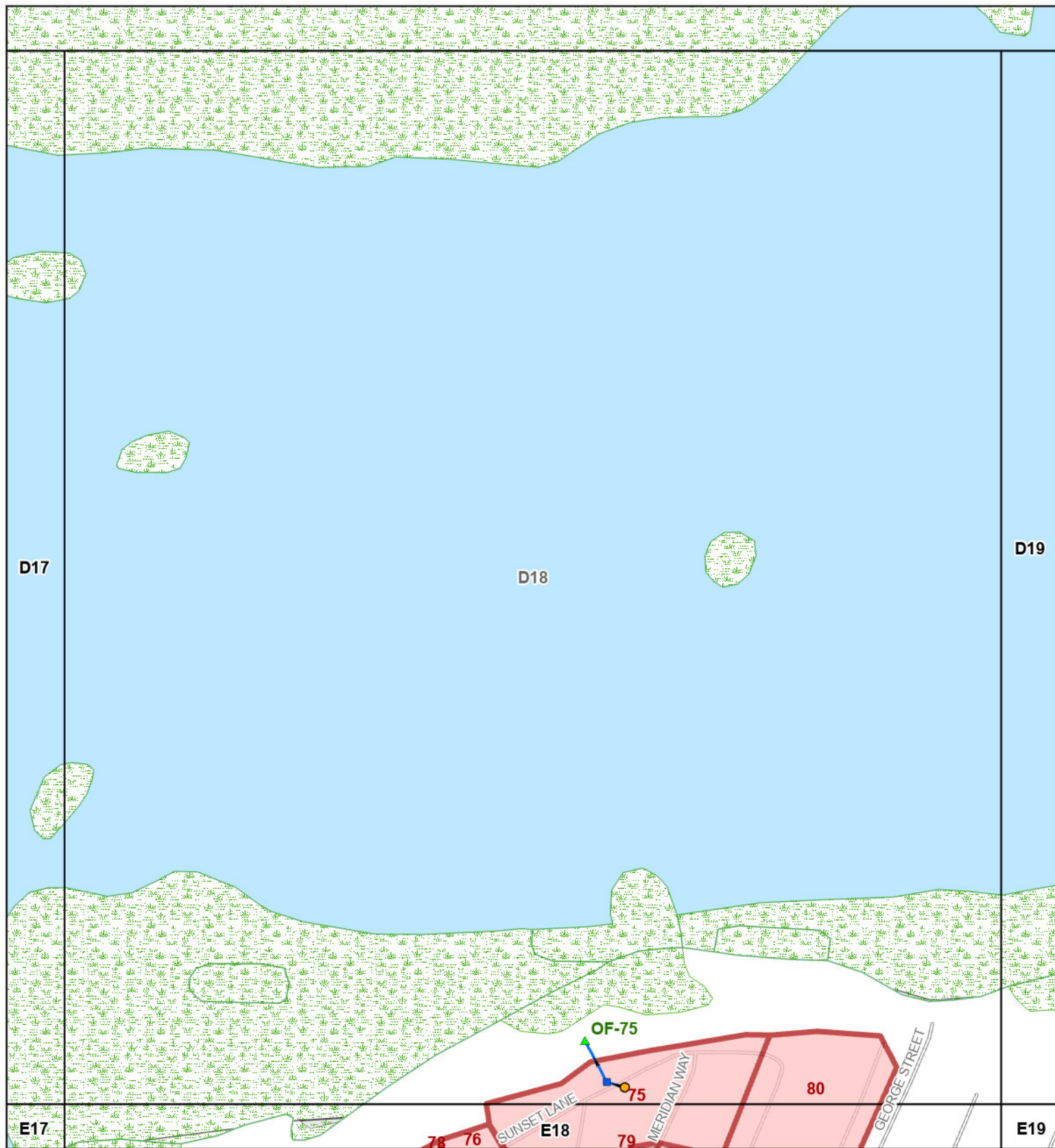
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| ● Drainage Manhole | — Storm Water Gravity Drain |
| ■ Stormwater BMP | — Swale |
| ★ Key Drainage Manhole | — Catchment |
| ✚ Interconnections | — Non-Urban Area |
| ▲ DOT Outfall | |

Stormwater Infrastructure Map Barnstable, MA

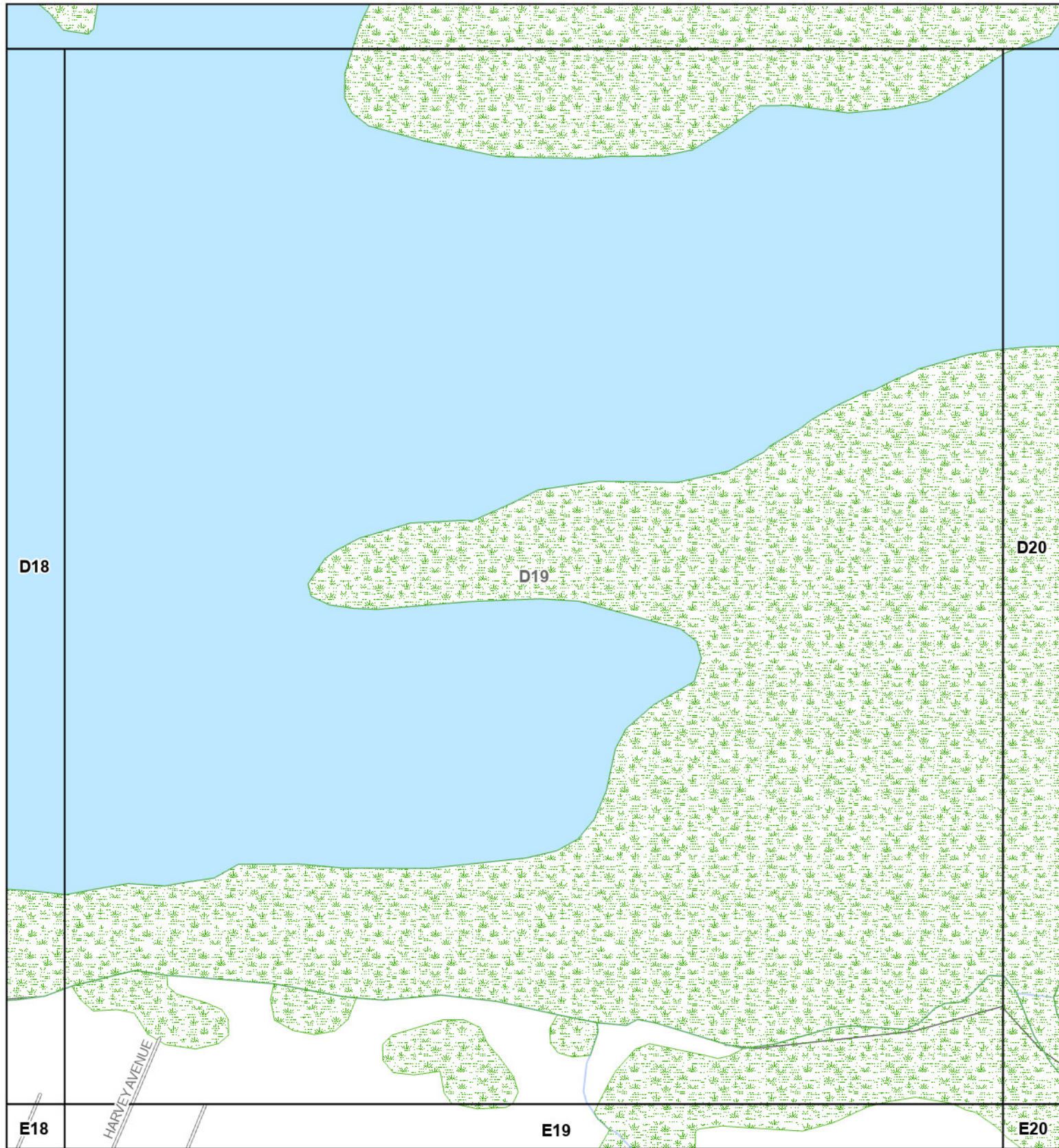
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| ● Drainage Manhole | — Storm Water Gravity Drain |
| ■ Stormwater BMP | — Swale |
| ★ Key Drainage Manhole | — Catchment |
| ✚ Interconnections | — Non-Urban Area |
| ▲ DOT Outfall | |

Stormwater Infrastructure Map Barnstable, MA

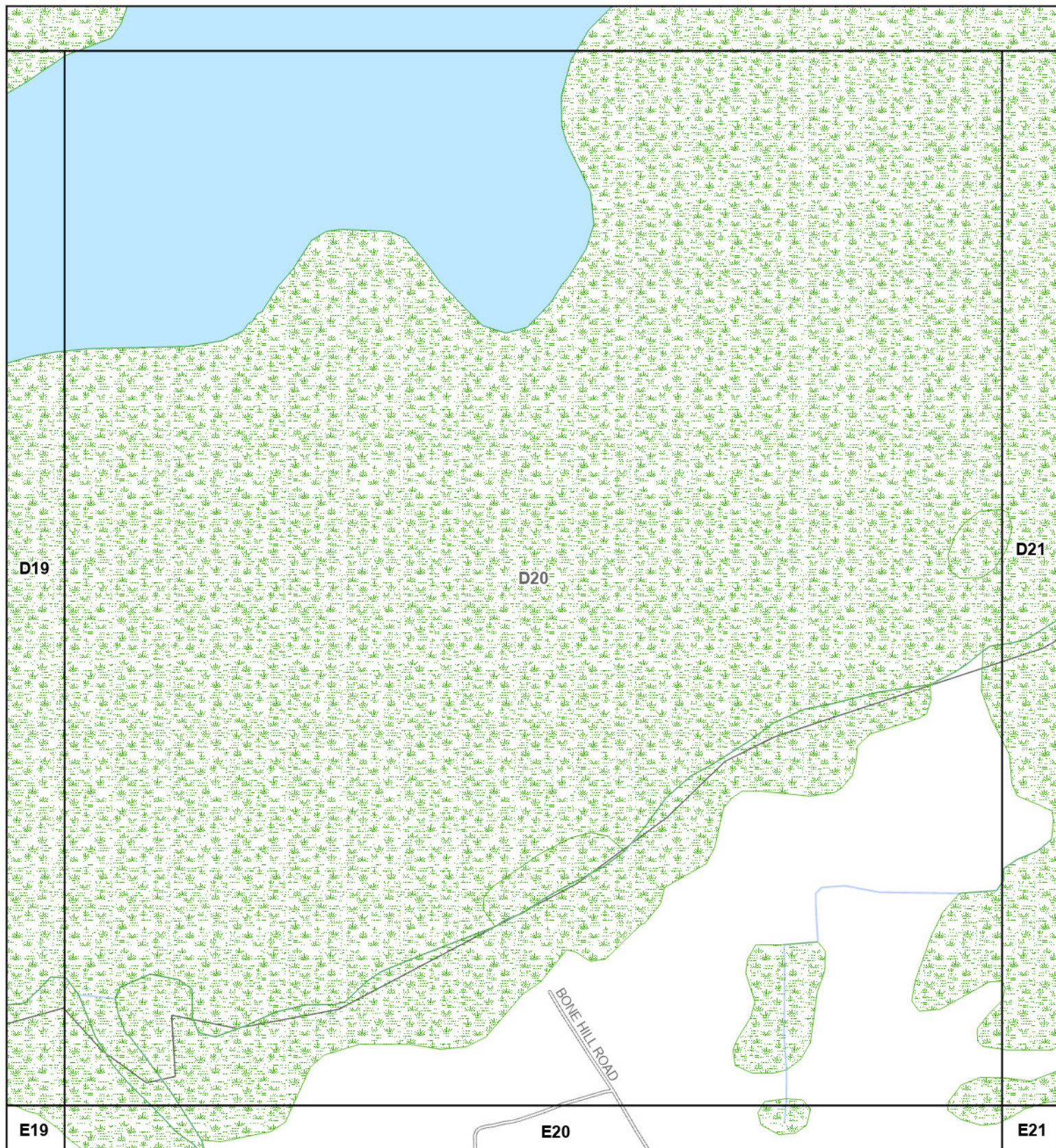
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| ● Drainage Manhole | — Storm Water Gravity Drain |
| ■ Stormwater BMP | — Swale |
| ★ Key Drainage Manhole | — Catchment |
| ✚ Interconnections | — Non-Urban Area |
| ▲ DOT Outfall | |

Stormwater Infrastructure Map Barnstable, MA

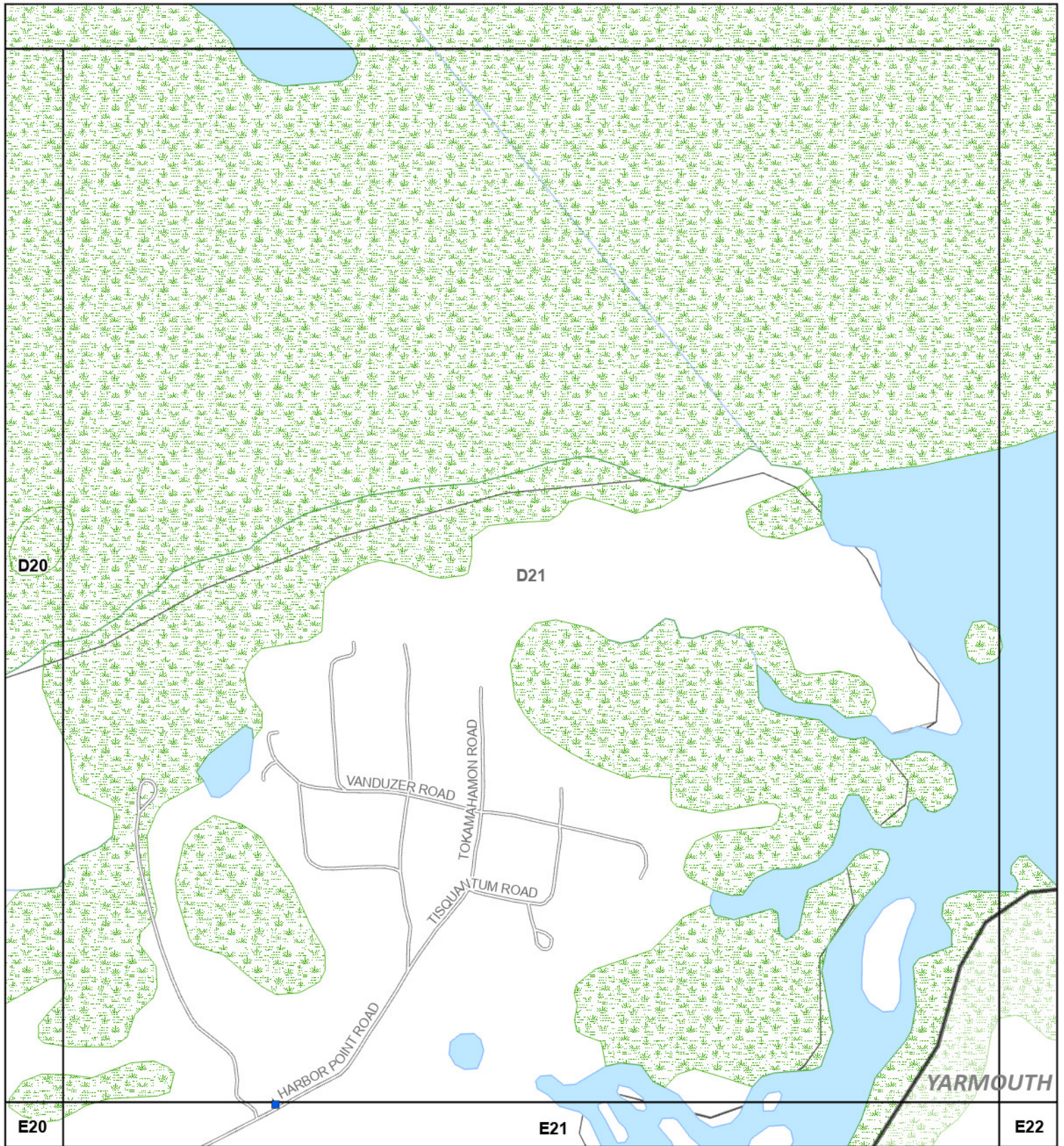
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| ● Drainage Manhole | — Storm Water Gravity Drain |
| ■ Stormwater BMP | — Swale |
| ★ Key Drainage Manhole | — Catchment |
| ✚ Interconnections | — Non-Urban Area |
| ▲ DOT Outfall | |

Stormwater Infrastructure Map Barnstable, MA

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| ▲ Outfalls | ○ DOT Manhole |
| ■ Catch Basin | □ DOT Catch Basin |
| ● Drainage Manhole | — Storm Water Gravity Drain |
| ■ Stormwater BMP | ~ Swale |
| ★ Key Drainage Manhole | ☞ Catchment |
| ✚ Interconnections | ☁ Non-Urban Area |
| △ DOT Outfall | |

**Stormwater Infrastructure
Map
Barnstable, MA**

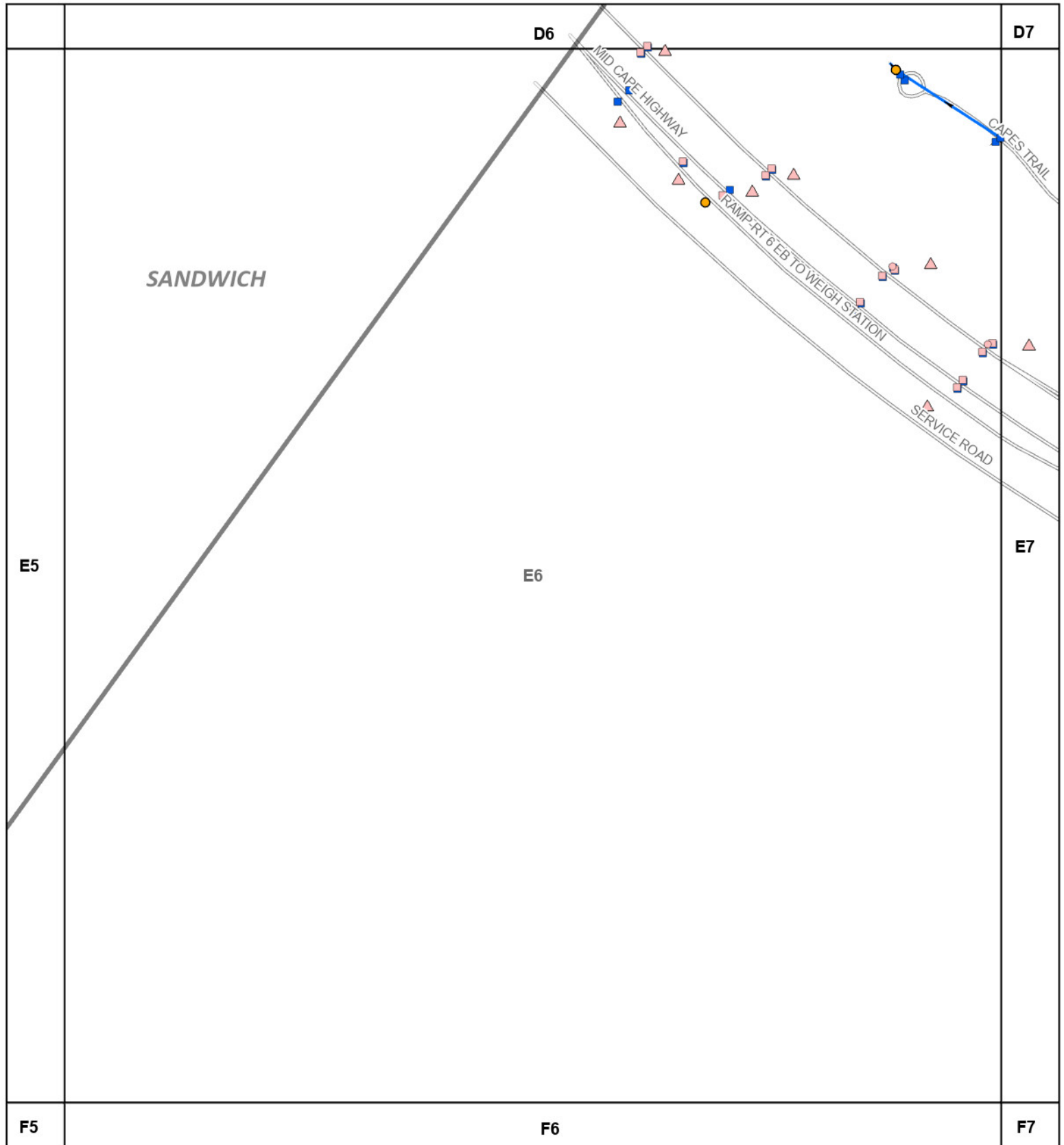
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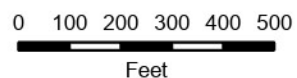
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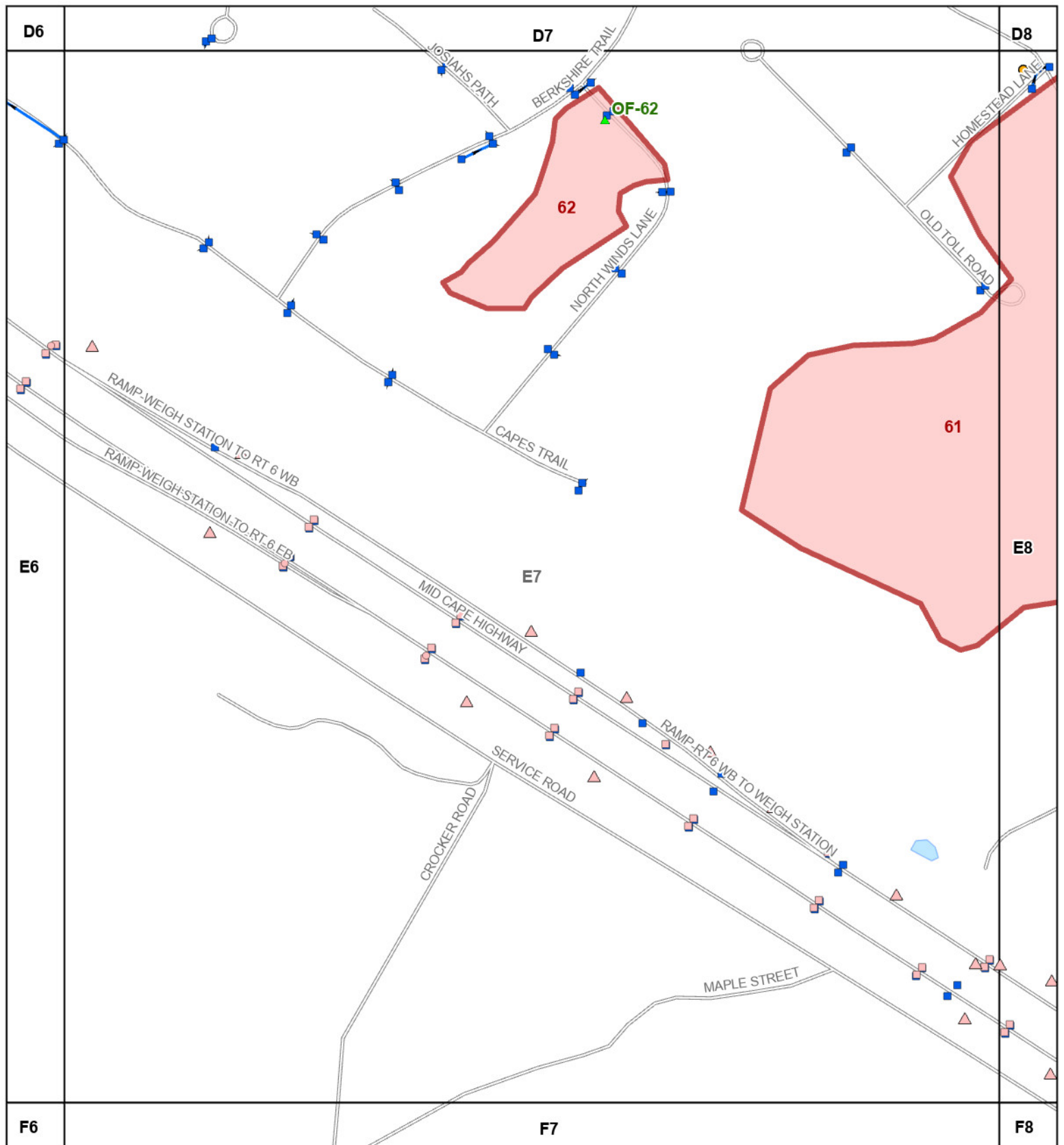
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| ▲ Outfalls | ○ DOT Manhole |
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| ■ Stormwater BMP | ~ Swale |
| ★ Key Drainage Manhole | ⬮ Catchment |
| ✚ Interconnections | ☁ Non-Urban Area |
| △ DOT Outfall | |

Stormwater Infrastructure Map Barnstable, MA

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| ▲ Outfalls | ○ DOT Manhole |
| ■ Catch Basin | ■ DOT Catch Basin |
| ● Drainage Manhole | — Storm Water Gravity Drain |
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| ★ Key Drainage Manhole | — Catchment |
| ✚ Interconnections | — Non-Urban Area |
| ▲ DOT Outfall | |

Stormwater Infrastructure Map Barnstable, MA

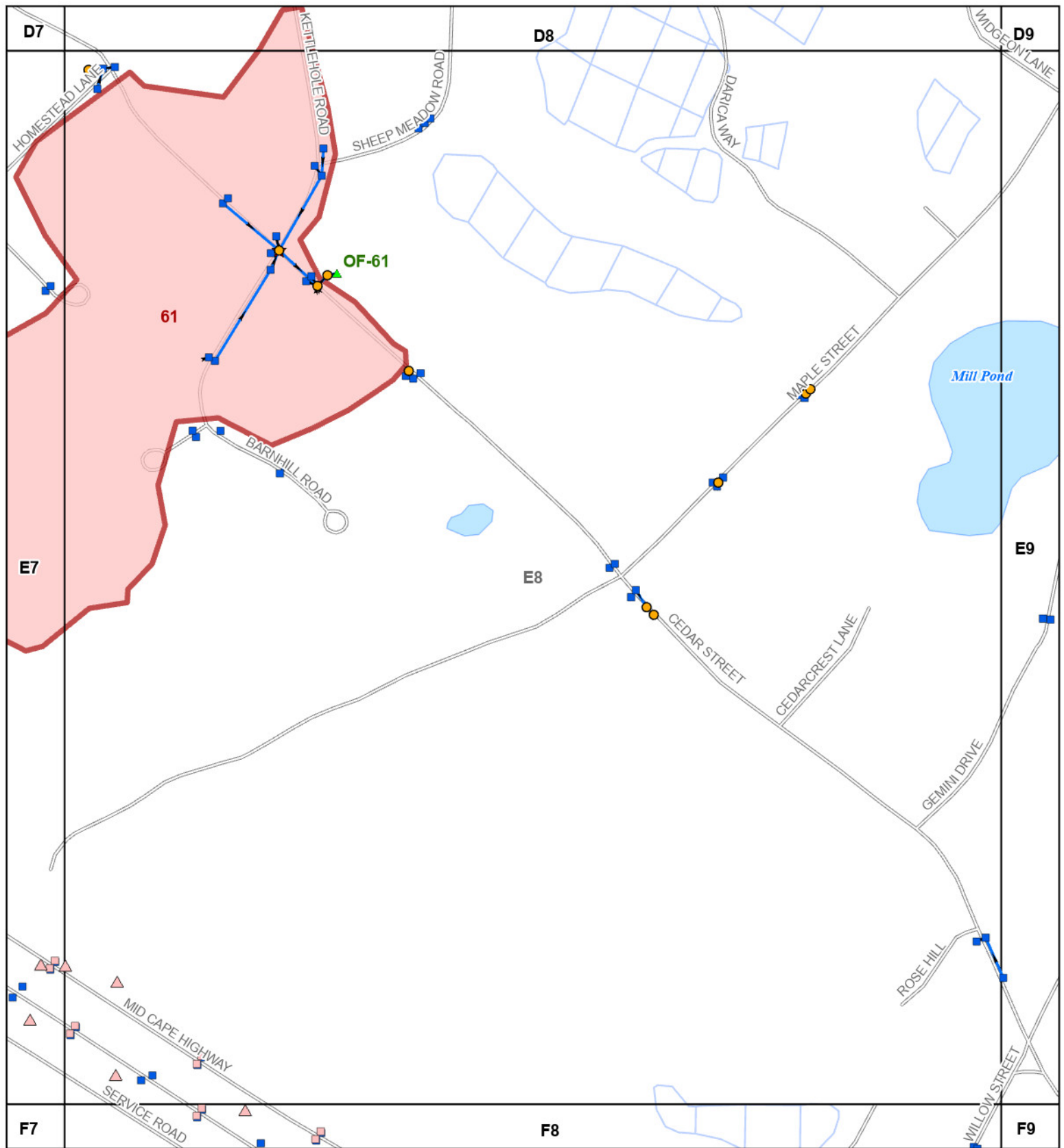
SHEET

E7

0 100 200 300 400 500
Feet



Comprehensive
Environmental
Incorporated



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| ■ Catch Basin | ■ DOT Catch Basin |
| ● Drainage Manhole | — Storm Water Gravity Drain |
| ■ Stormwater BMP | — Swale |
| ★ Key Drainage Manhole | — Catchment |
| ✚ Interconnections | — Non-Urban Area |
| ▲ DOT Outfall | |

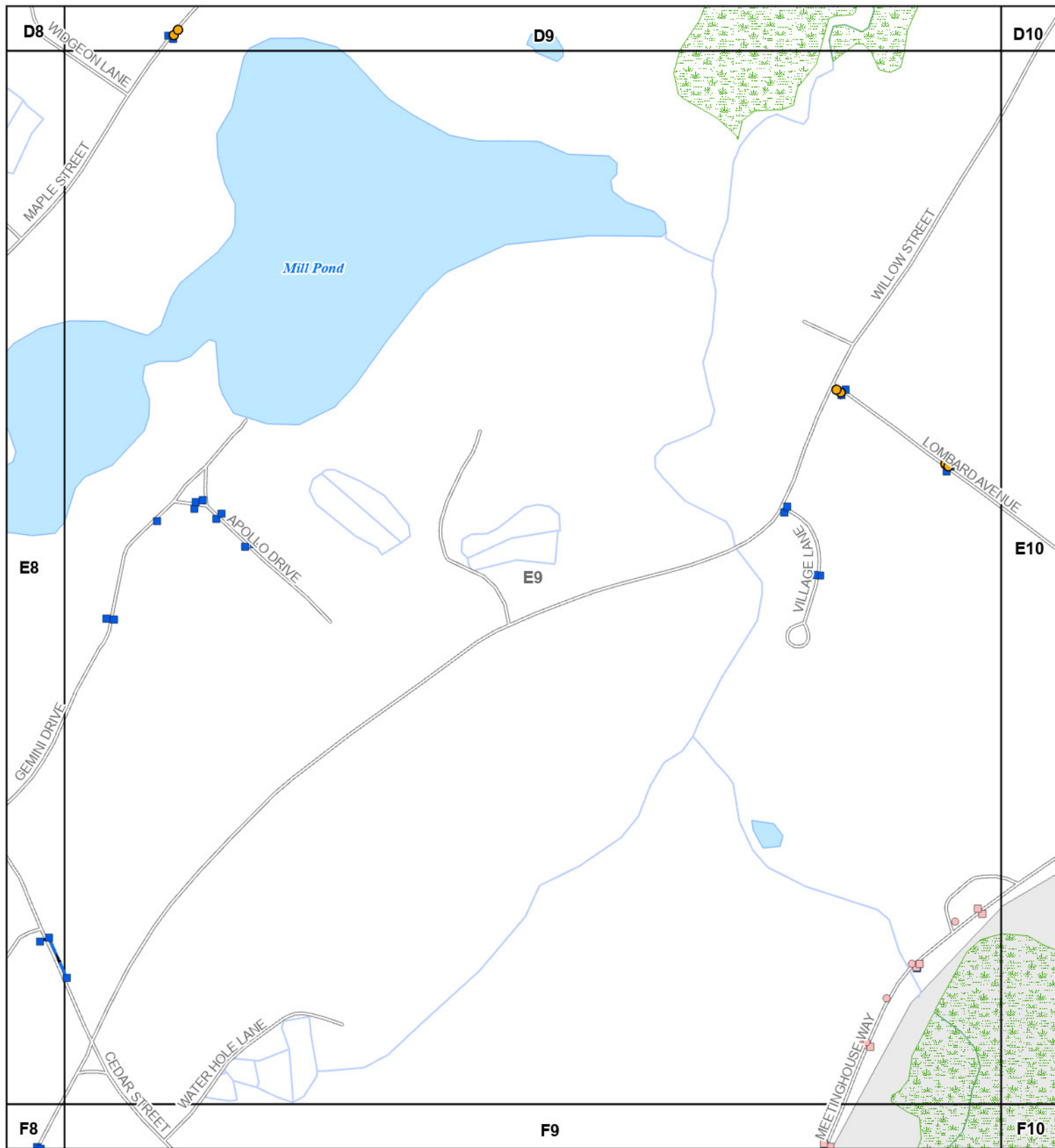
Stormwater Infrastructure Map Barnstable, MA

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| ▲ Outfalls | ● DOT Manhole |
| ■ Catch Basin | ■ DOT Catch Basin |
| ● Drainage Manhole | — Storm Water Gravity Drain |
| ■ Stormwater BMP | — Swale |
| ★ Key Drainage Manhole | — Catchment |
| ✚ Interconnections | — Non-Urban Area |
| ▲ DOT Outfall | |

Stormwater Infrastructure Map Barnstable, MA

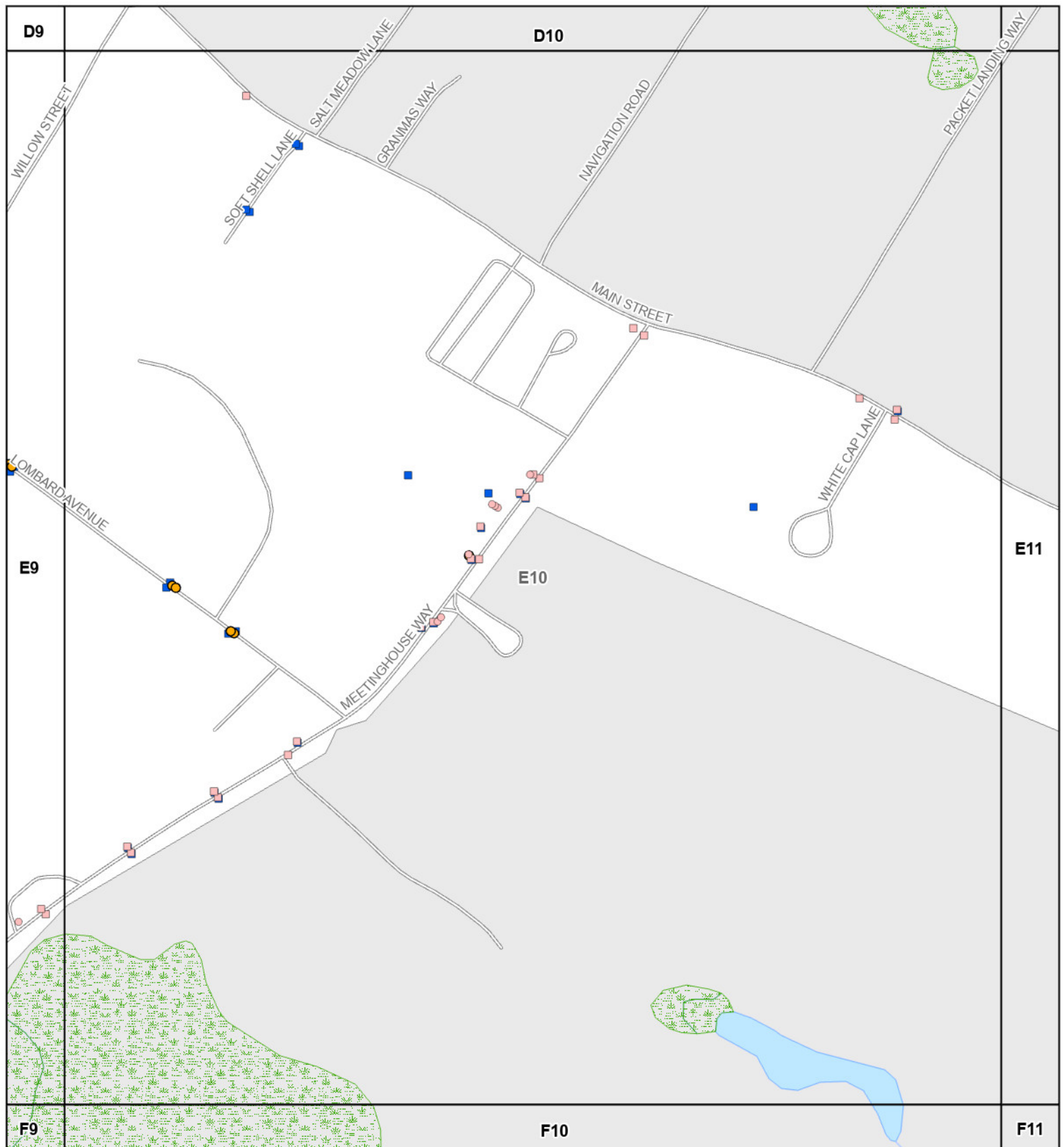
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| ● Drainage Manhole | — Storm Water Gravity Drain |
| ■ Stormwater BMP | — Swale |
| ★ Key Drainage Manhole | — Catchment |
| ✚ Interconnections | — Non-Urban Area |
| ▲ DOT Outfall | |

Stormwater Infrastructure Map Barnstable, MA

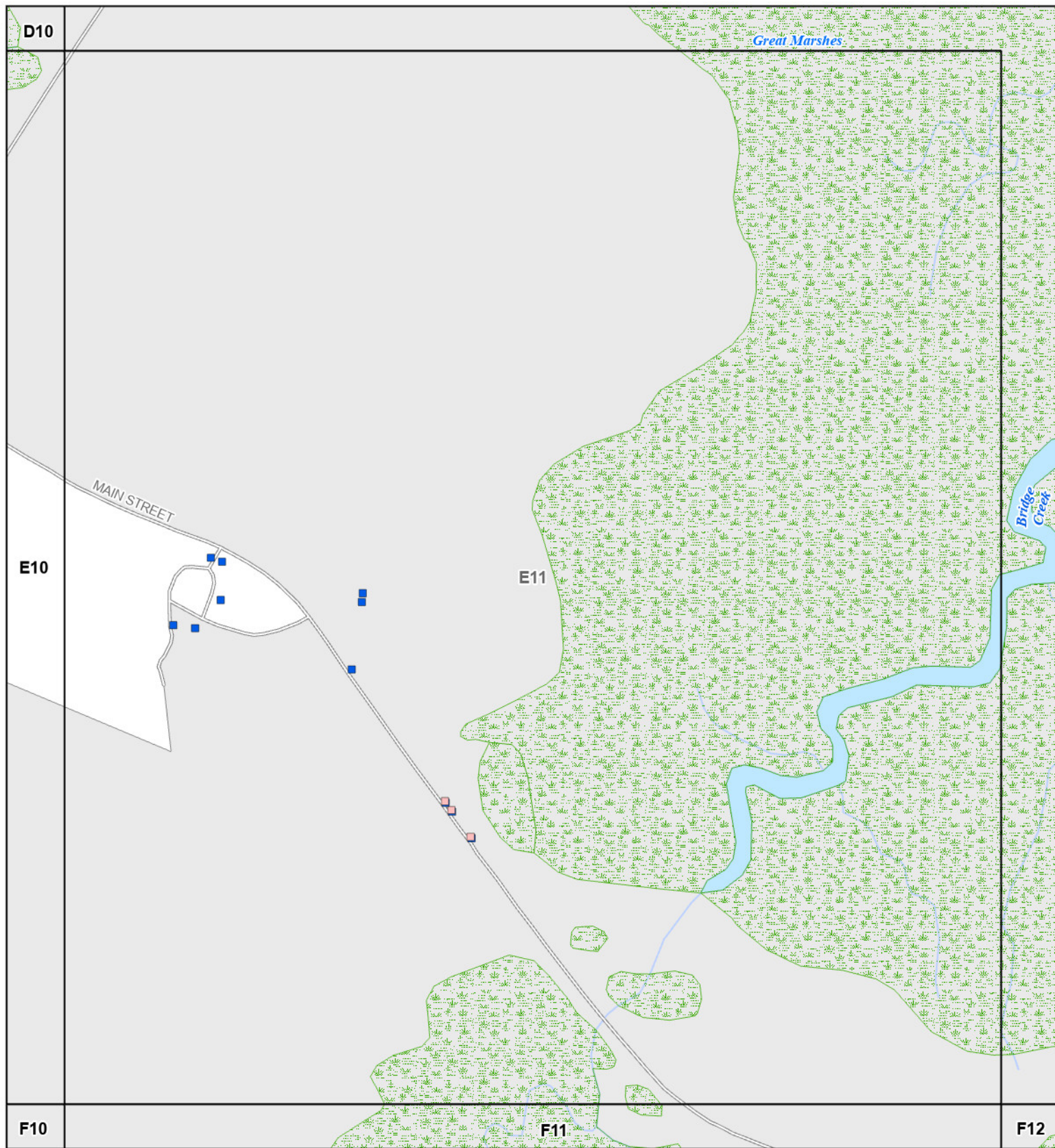
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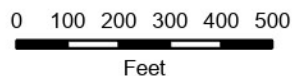
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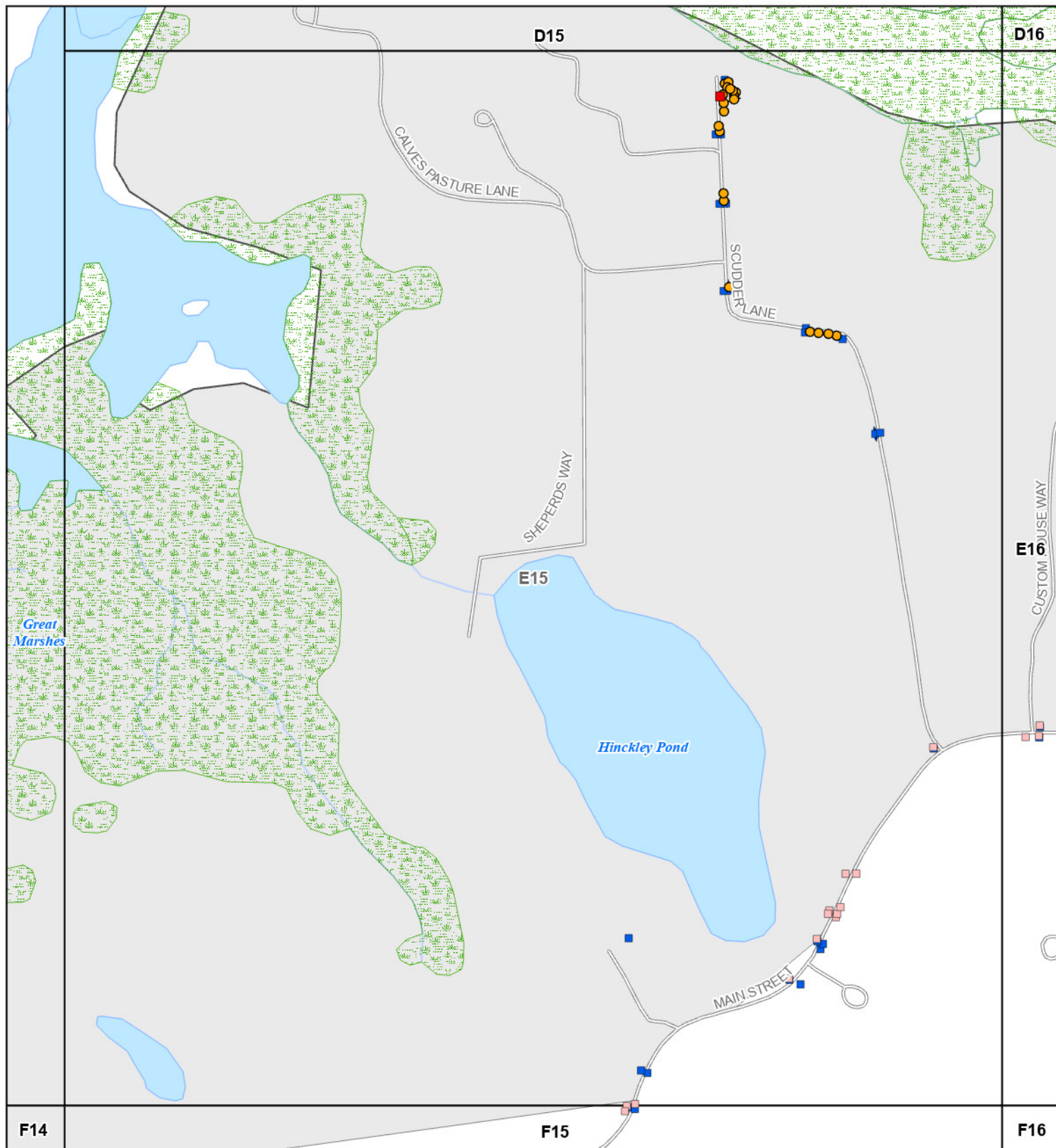
Stormwater Infrastructure Map Barnstable, MA

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| ■ Catch Basin | ■ DOT Catch Basin |
| ● Drainage Manhole | — Storm Water Gravity Drain |
| ■ Stormwater BMP | ~ Swale |
| ★ Key Drainage Manhole | ○ Catchment |
| ✚ Interconnections | ○ Non-Urban Area |
| ▲ DOT Outfall | |

Stormwater Infrastructure Map Barnstable, MA

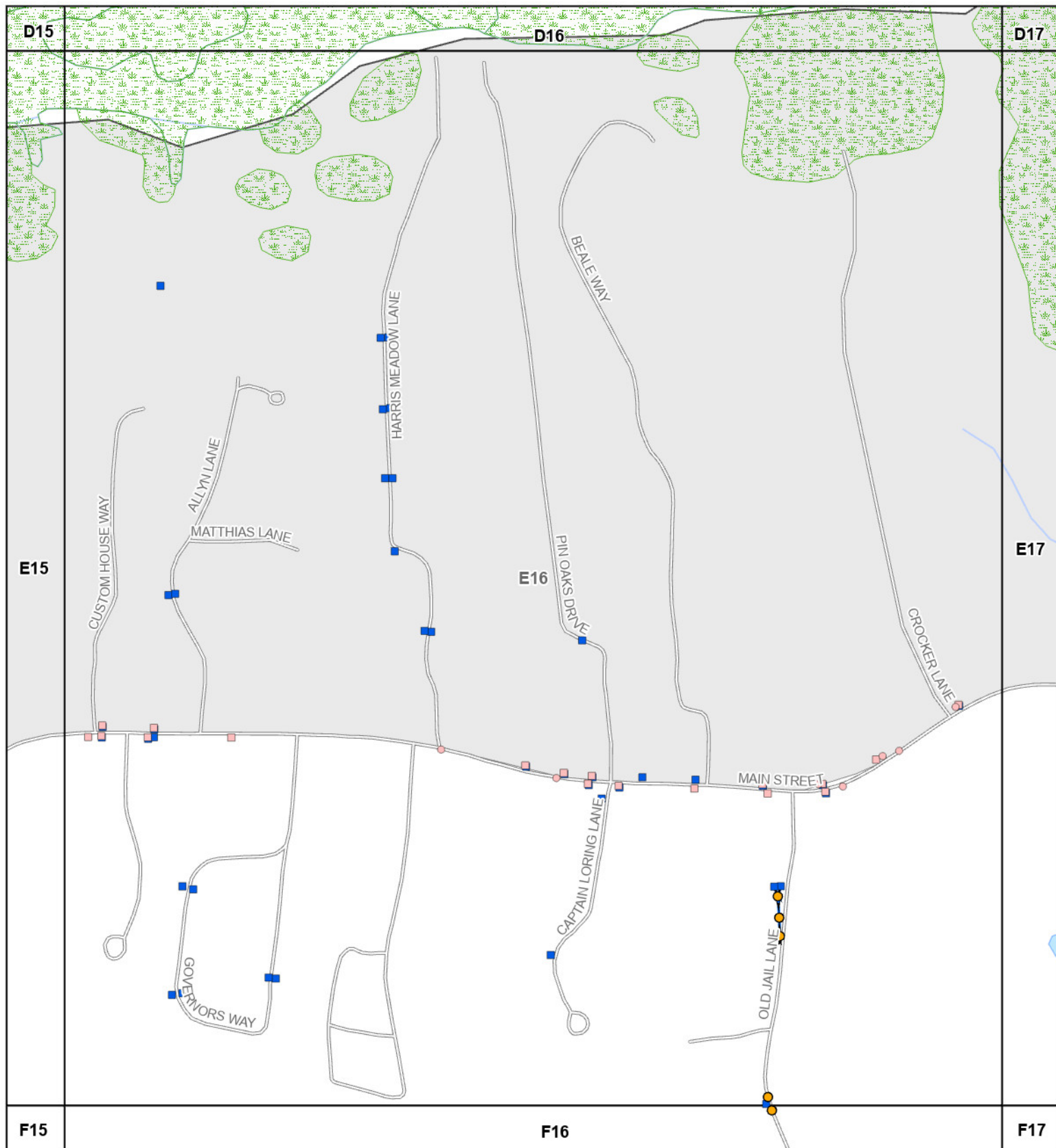
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| ● Drainage Manhole | — Storm Water Gravity Drain |
| ■ Stormwater BMP | — Swale |
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| ✚ Interconnections | — Non-Urban Area |
| ▲ DOT Outfall | |

Stormwater Infrastructure Map Barnstable, MA

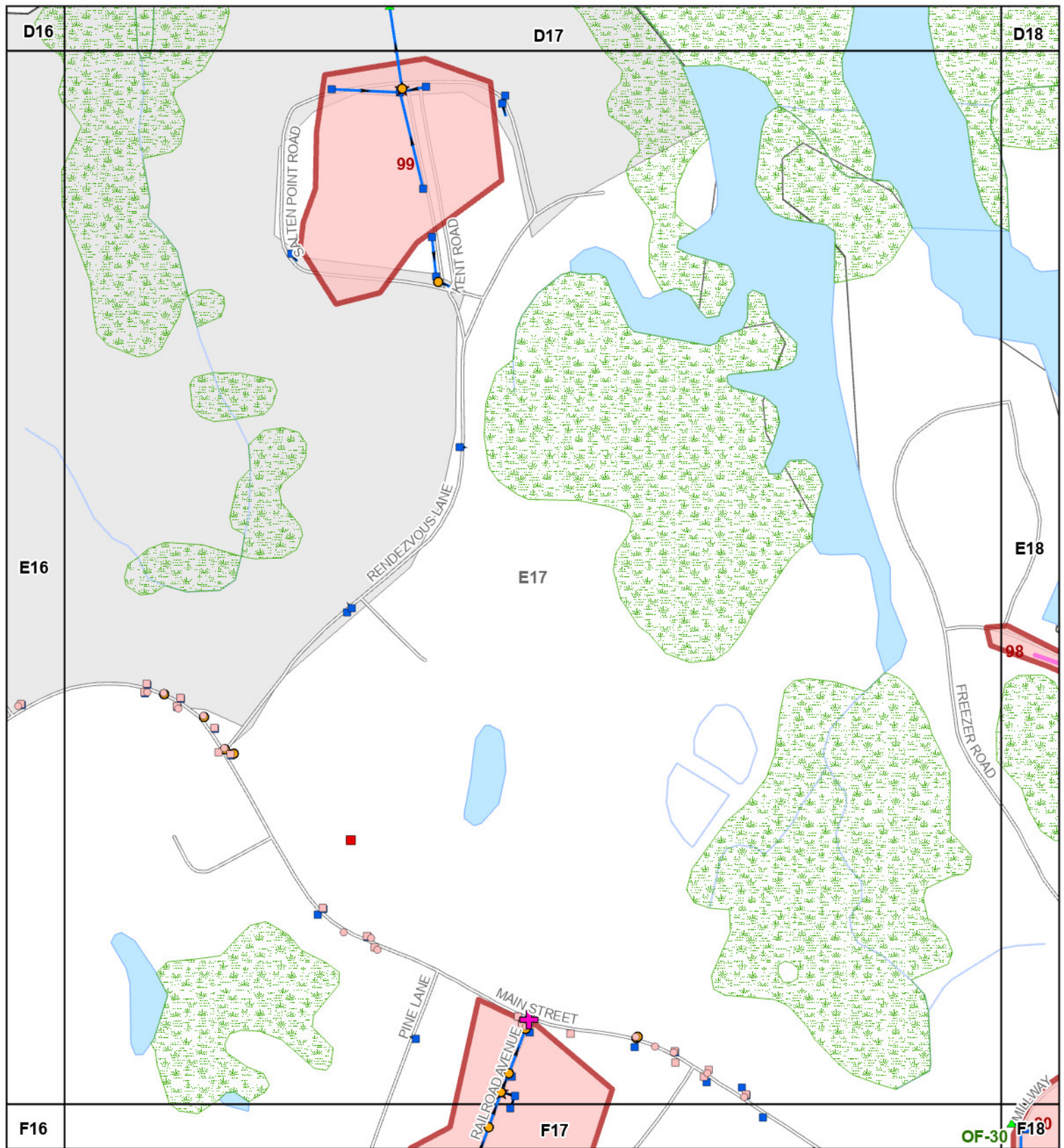
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| ■ Catch Basin | ■ DOT Catch Basin |
| ● Drainage Manhole | — Storm Water Gravity Drain |
| ■ Stormwater BMP | — Swale |
| ★ Key Drainage Manhole | — Catchment |
| ✚ Interconnections | — Non-Urban Area |
| ▲ DOT Outfall | |

Stormwater Infrastructure Map Barnstable, MA

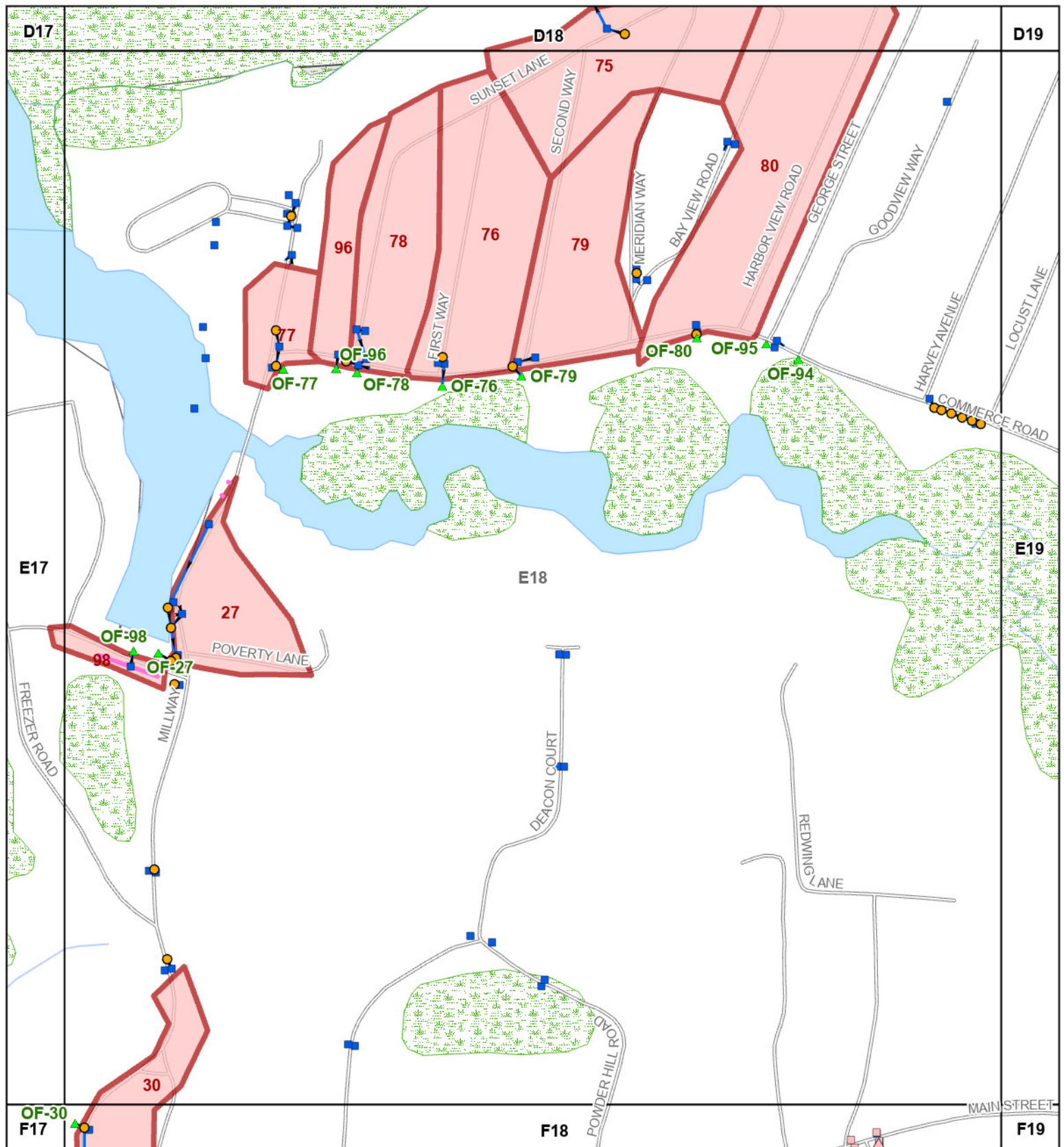
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| ■ Catch Basin | ■ DOT Catch Basin |
| ● Drainage Manhole | — Storm Water Gravity Drain |
| ■ Stormwater BMP | — Swale |
| ★ Key Drainage Manhole | — Catchment |
| ✚ Interconnections | — Non-Urban Area |
| △ DOT Outfall | |

Stormwater Infrastructure Map Barnstable, MA

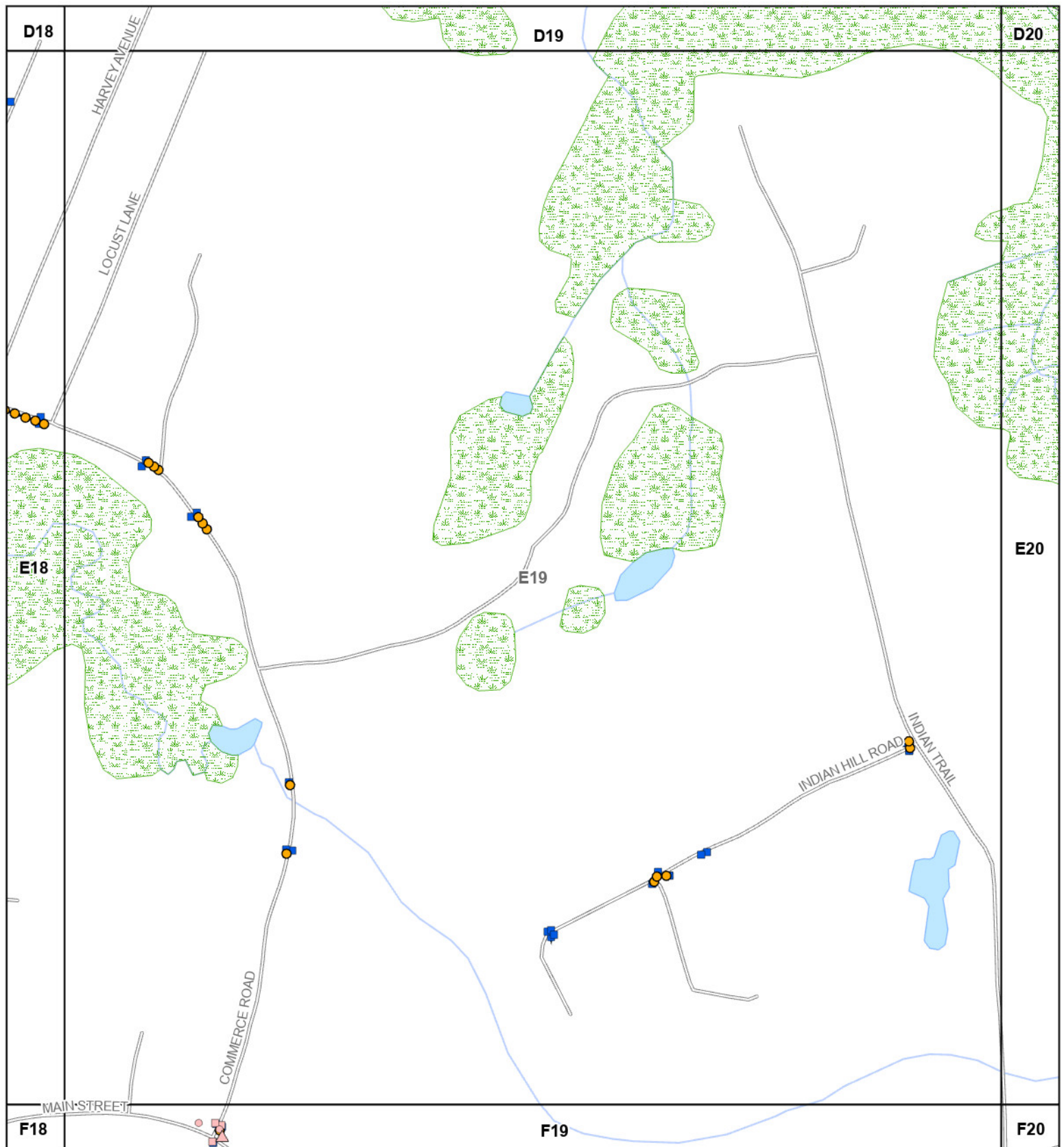
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| ■ Catch Basin | ■ DOT Catch Basin |
| ● Drainage Manhole | — Storm Water Gravity Drain |
| ■ Stormwater BMP | — Swale |
| ★ Key Drainage Manhole | — Catchment |
| ✚ Interconnections | — Non-Urban Area |
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Stormwater Infrastructure Map Barnstable, MA

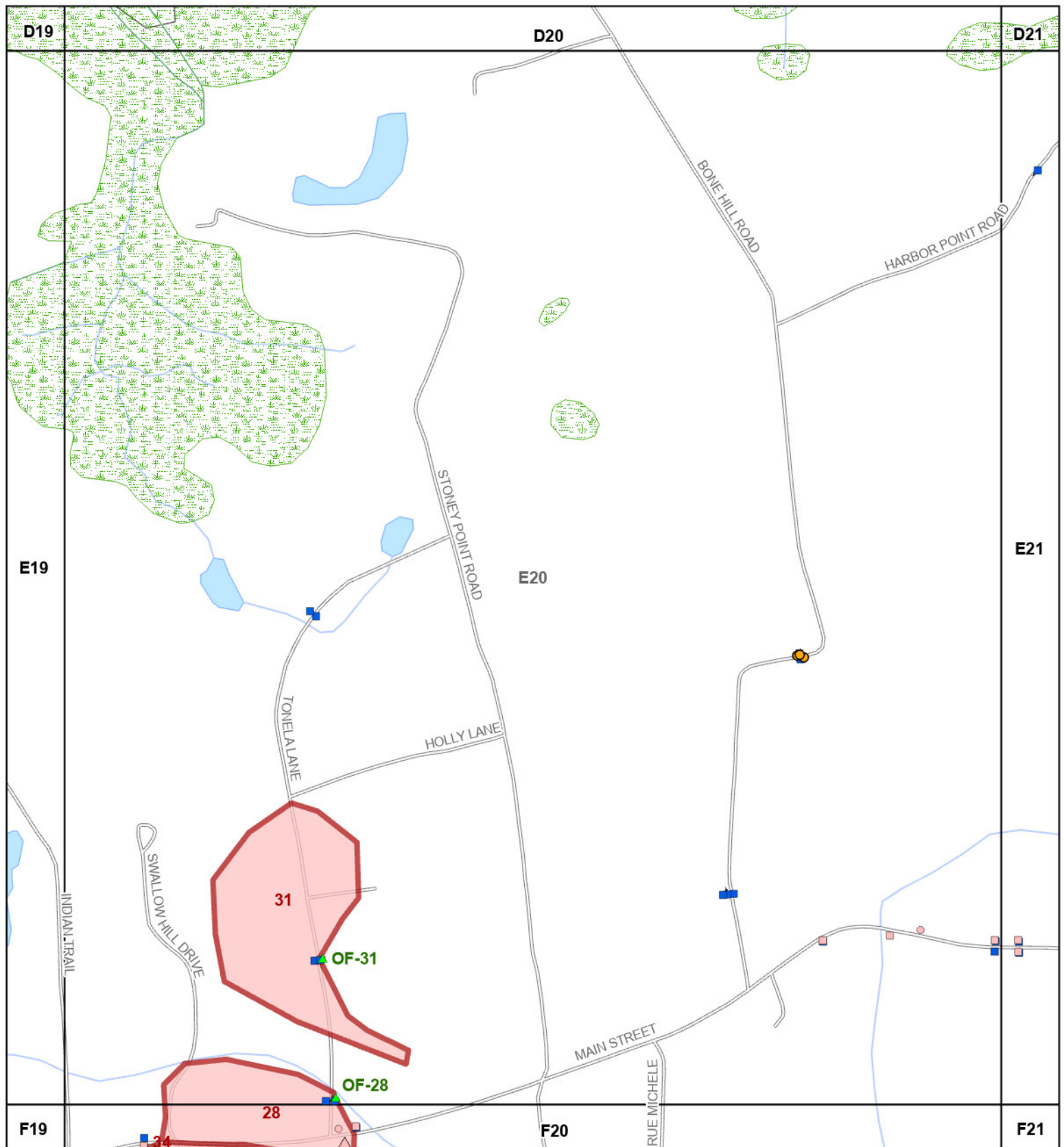
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| ▲ Outfalls | ● DOT Manhole |
| ■ Catch Basin | ■ DOT Catch Basin |
| ● Drainage Manhole | — Storm Water Gravity Drain |
| ■ Stormwater BMP | — Swale |
| ★ Key Drainage Manhole | — Catchment |
| ✚ Interconnections | — Non-Urban Area |
| ▲ DOT Outfall | |

Stormwater Infrastructure Map Barnstable, MA

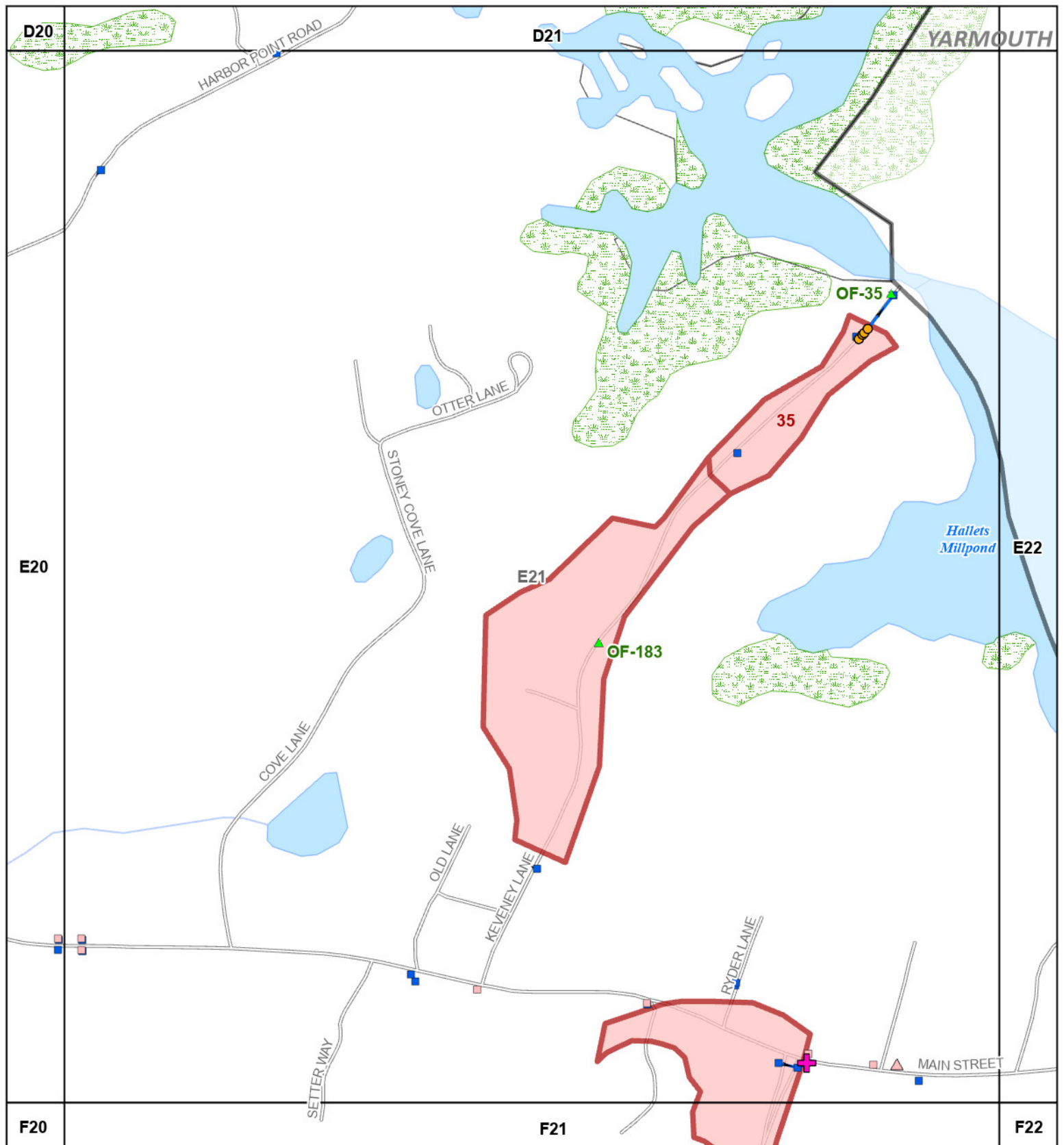
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| ▲ Outfalls | ○ DOT Manhole |
| ■ Catch Basin | ■ DOT Catch Basin |
| ● Drainage Manhole | — Storm Water Gravity Drain |
| ■ Stormwater BMP | — Swale |
| ★ Key Drainage Manhole | — Catchment |
| ✚ Interconnections | — Non-Urban Area |
| ▲ DOT Outfall | |

Stormwater Infrastructure Map Barnstable, MA

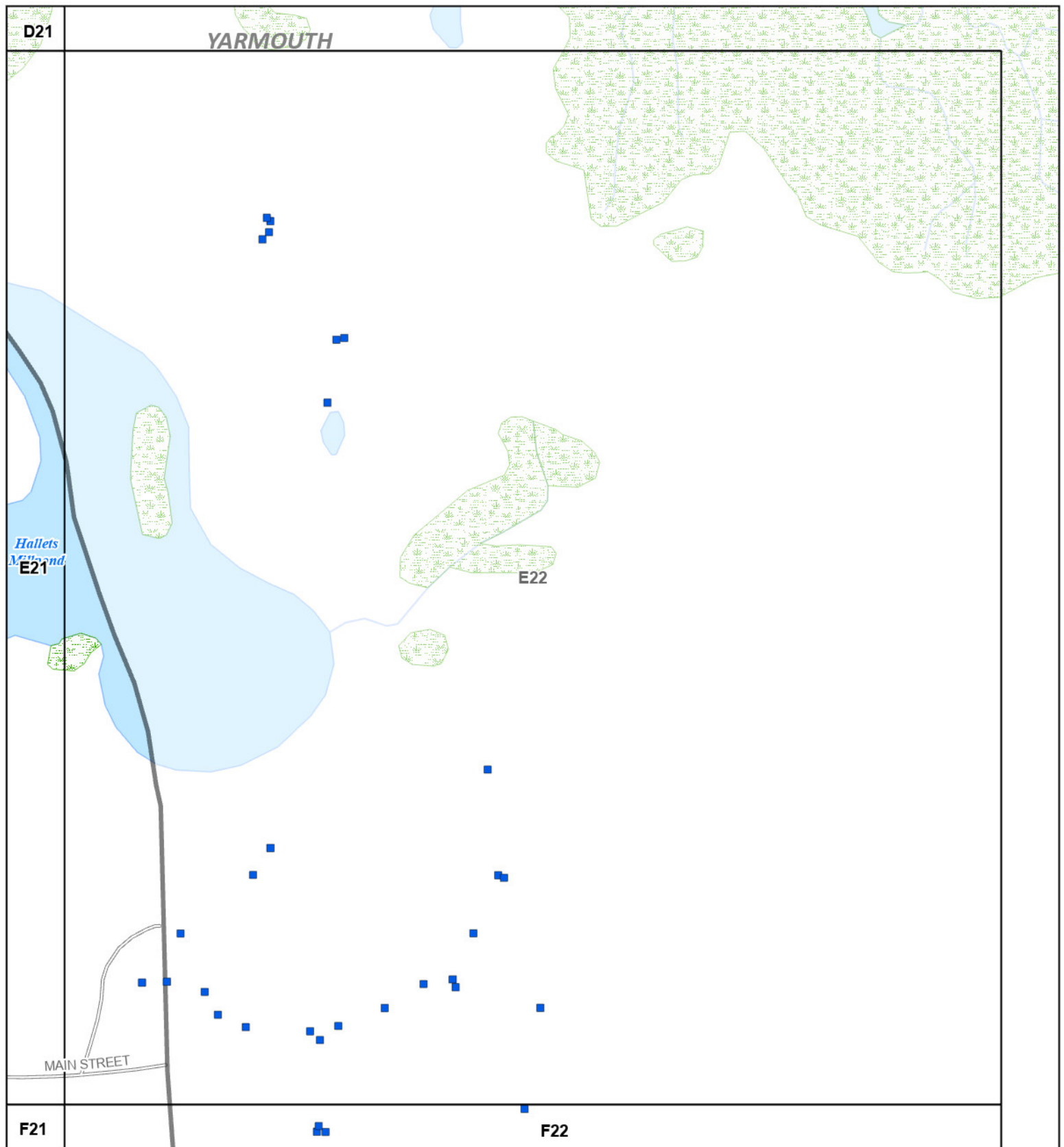
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| ▲ Outfalls | ○ DOT Manhole |
| ■ Catch Basin | ■ DOT Catch Basin |
| ● Drainage Manhole | — Storm Water Gravity Drain |
| ■ Stormwater BMP | — Swale |
| ★ Key Drainage Manhole | — Catchment |
| ✚ Interconnections | — Non-Urban Area |
| ▲ DOT Outfall | |

Stormwater Infrastructure Map Barnstable, MA

SHEET

E22

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SANDWICH

E5

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G4

G5

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| ▲ Outfalls | ○ DOT Manhole |
| ■ Catch Basin | ■ DOT Catch Basin |
| ● Drainage Manhole | — Storm Water Gravity Drain |
| ■ Stormwater BMP | — Swale |
| ★ Key Drainage Manhole | — Catchment |
| ✚ Interconnections | — Non-Urban Area |
| △ DOT Outfall | |

**Stormwater Infrastructure
Map
Barnstable, MA**

SHEET

F4

0 100 200 300 400 500
Feet



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Incorporated

SANDWICH

E5

E6

F4

F5

F6

G4

G5

G6

CROOKED CARTWAY

POPPLE BOTTOM ROAD

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| ▲ Outfalls | ○ DOT Manhole |
| ■ Catch Basin | ■ DOT Catch Basin |
| ● Drainage Manhole | — Storm Water Gravity Drain |
| ■ Stormwater BMP | — Swale |
| ★ Key Drainage Manhole | — Catchment |
| ✚ Interconnections | — Non-Urban Area |
| △ DOT Outfall | |

**Stormwater Infrastructure
Map
Barnstable, MA**

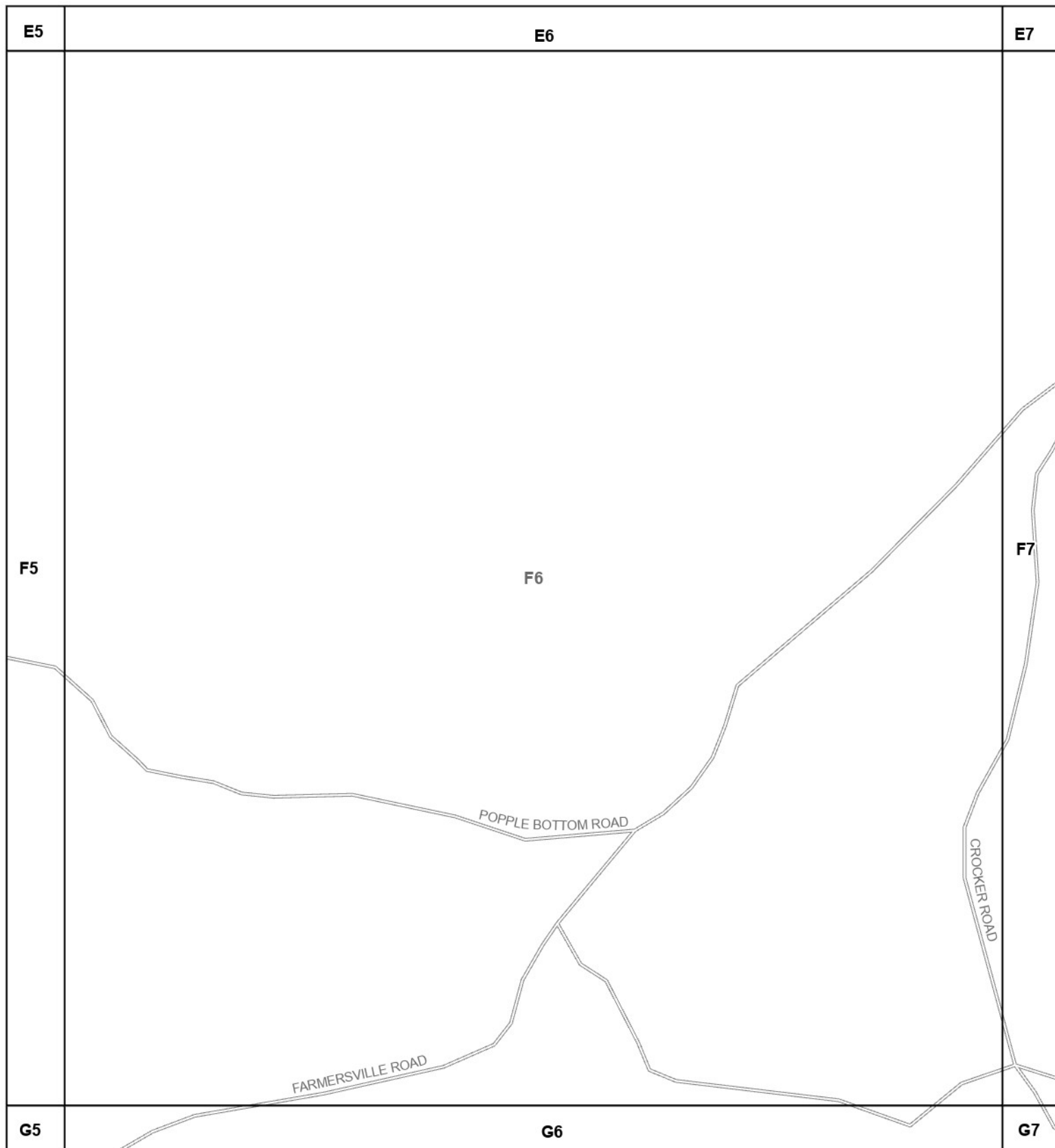
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| ▲ Outfalls | ○ DOT Manhole |
| ■ Catch Basin | ■ DOT Catch Basin |
| ● Drainage Manhole | — Storm Water Gravity Drain |
| ■ Stormwater BMP | — Swale |
| ★ Key Drainage Manhole | — Catchment |
| ✚ Interconnections | — Non-Urban Area |
| △ DOT Outfall | |

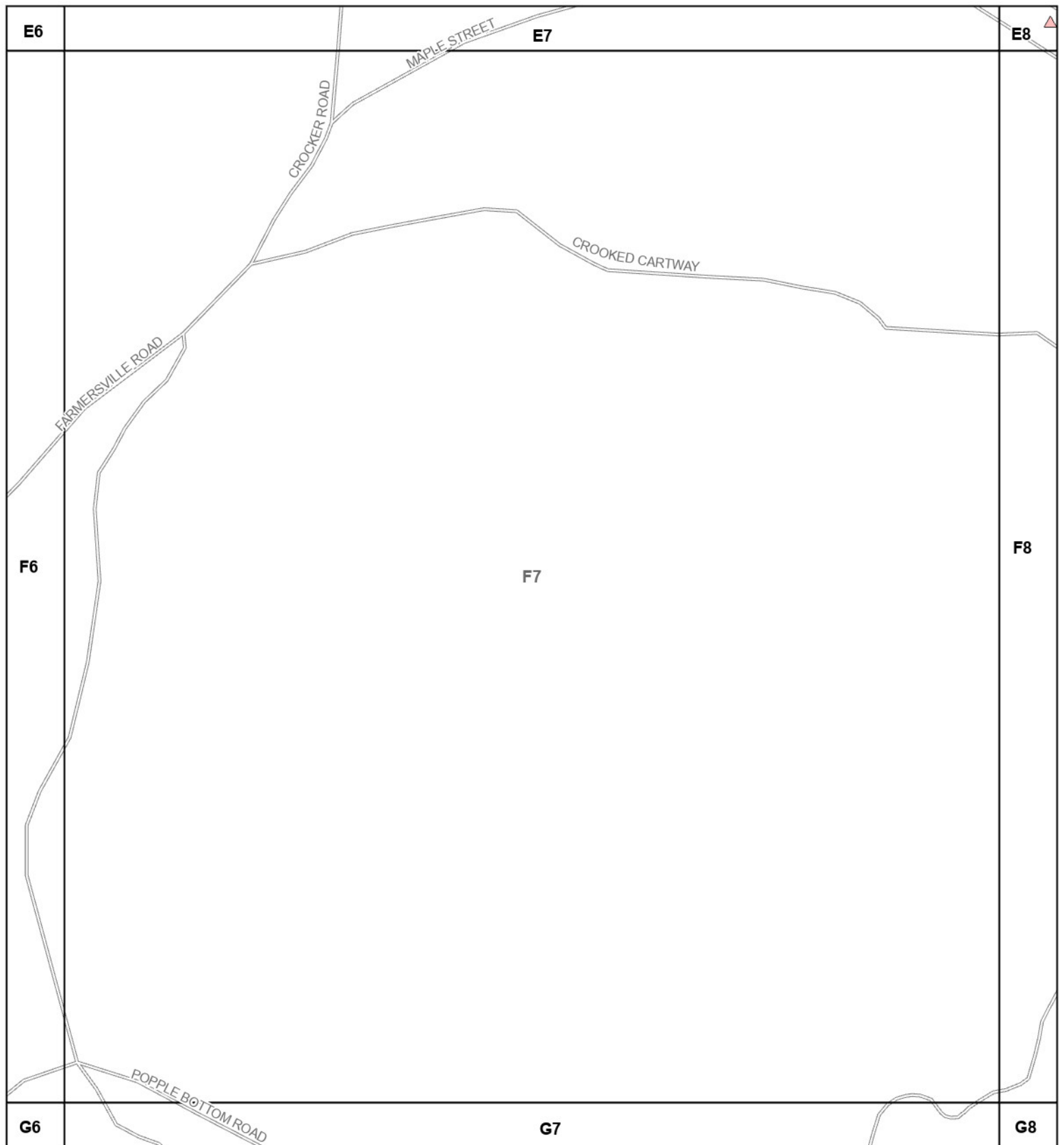
Stormwater Infrastructure Map Barnstable, MA

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| ▲ Outfalls | ● DOT Manhole |
| ■ Catch Basin | ■ DOT Catch Basin |
| ● Drainage Manhole | — Storm Water Gravity Drain |
| ■ Stormwater BMP | — Swale |
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| ✚ Interconnections | — Non-Urban Area |
| ▲ DOT Outfall | |

Stormwater Infrastructure Map Barnstable, MA

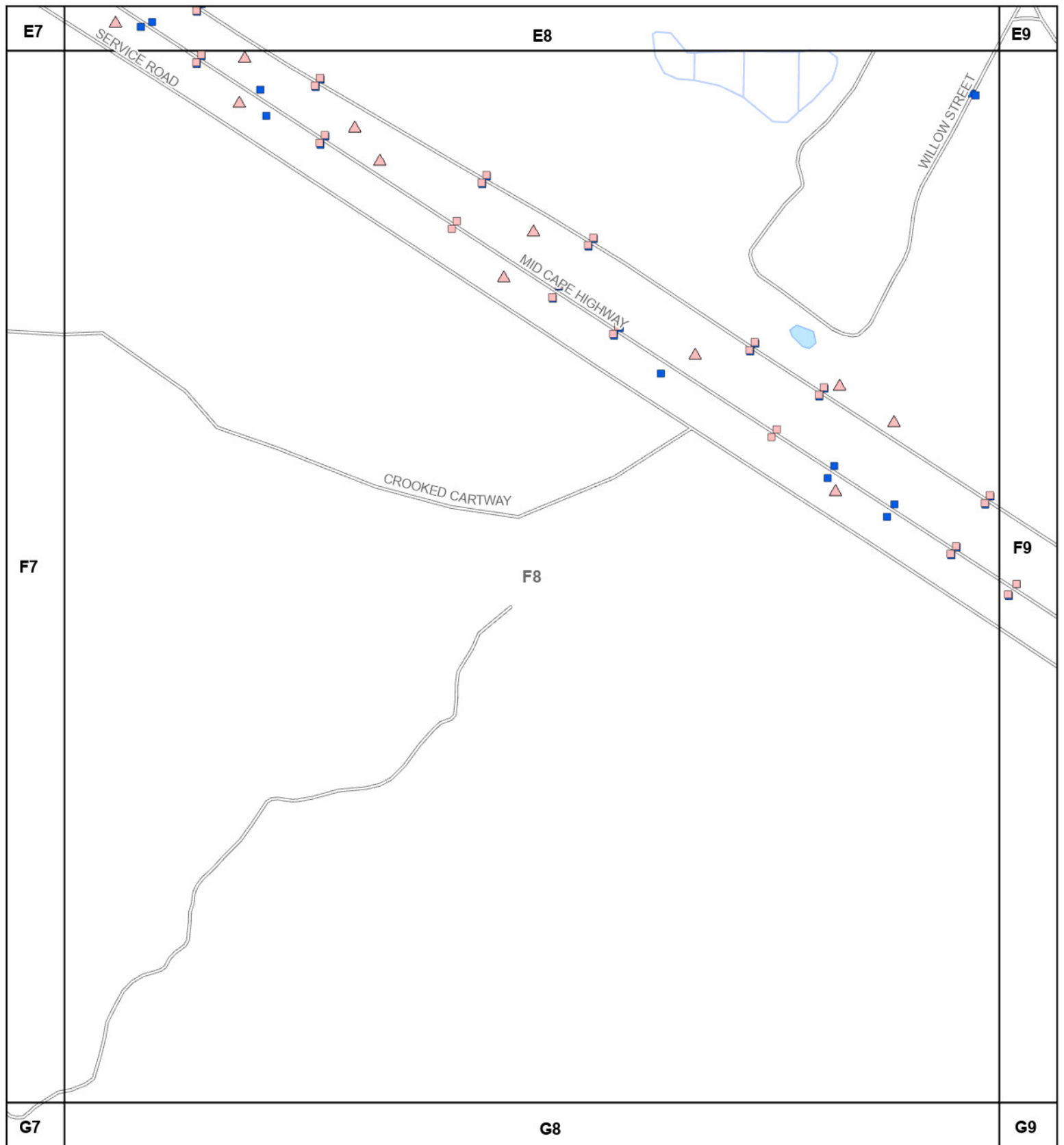
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| ▲ Outfalls | ○ DOT Manhole |
| ■ Catch Basin | ■ DOT Catch Basin |
| ● Drainage Manhole | — Storm Water Gravity Drain |
| ■ Stormwater BMP | — Swale |
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| ✚ Interconnections | — Non-Urban Area |
| ▲ DOT Outfall | |

Stormwater Infrastructure Map Barnstable, MA

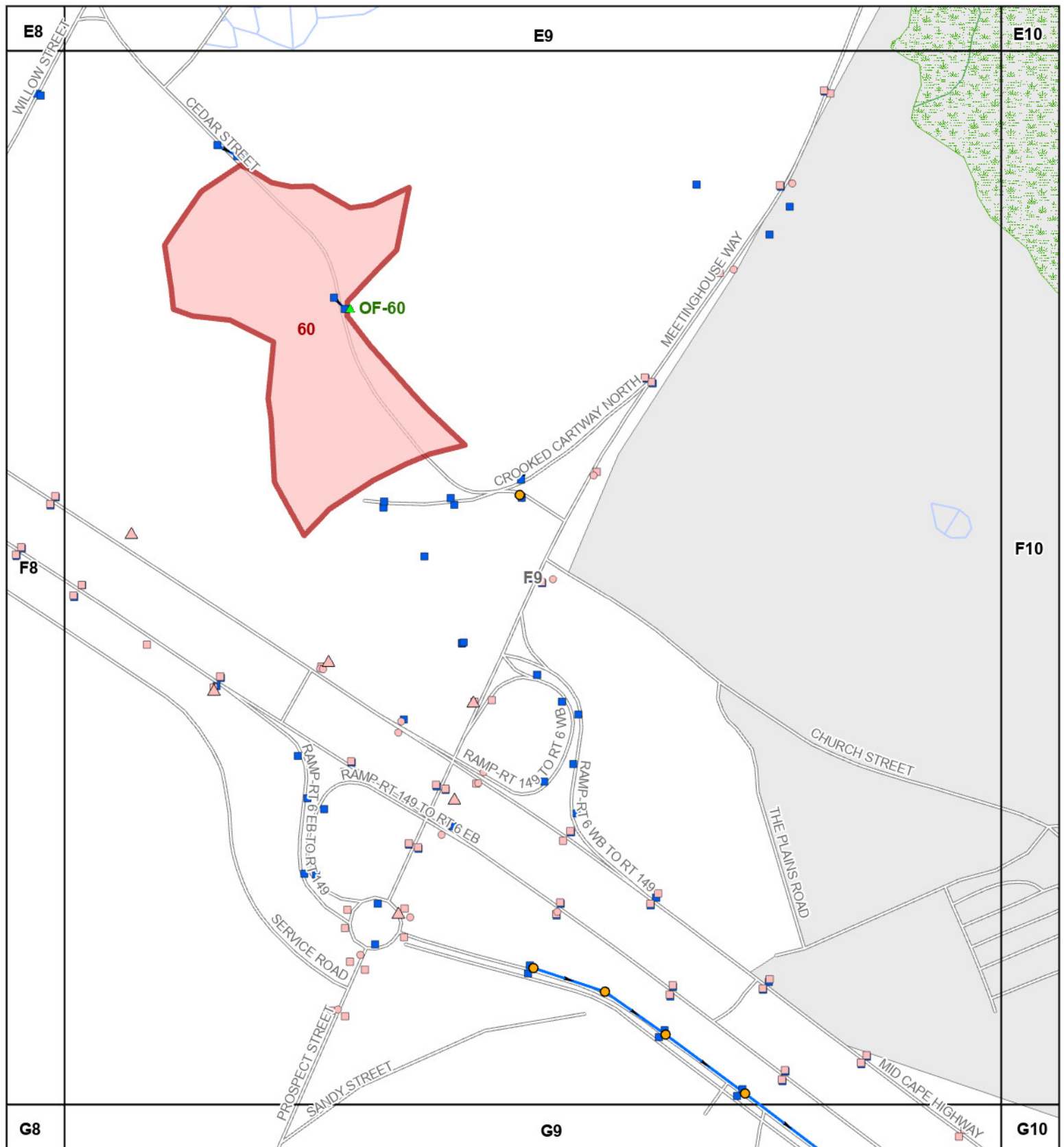
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| ▲ Outfalls | ● DOT Manhole |
| ■ Catch Basin | ■ DOT Catch Basin |
| ● Drainage Manhole | — Storm Water Gravity Drain |
| ■ Stormwater BMP | — Swale |
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| ✚ Interconnections | — Non-Urban Area |
| ▲ DOT Outfall | |

Stormwater Infrastructure Map Barnstable, MA

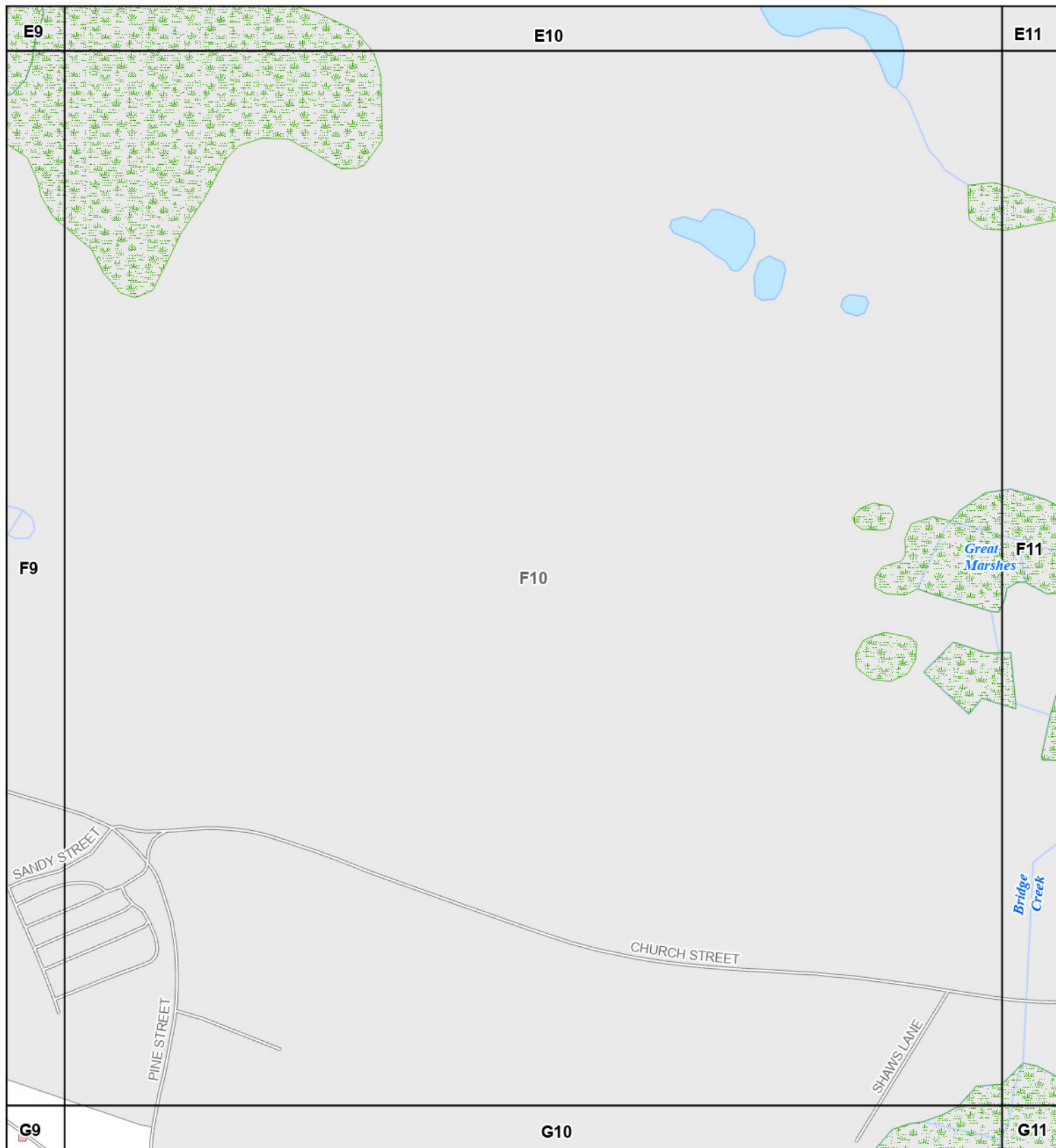
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| ▲ Outfalls | ● DOT Manhole |
| ■ Catch Basin | ■ DOT Catch Basin |
| ● Drainage Manhole | — Storm Water Gravity Drain |
| ■ Stormwater BMP | — Swale |
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| ✚ Interconnections | — Non-Urban Area |
| ▲ DOT Outfall | |

Stormwater Infrastructure Map Barnstable, MA

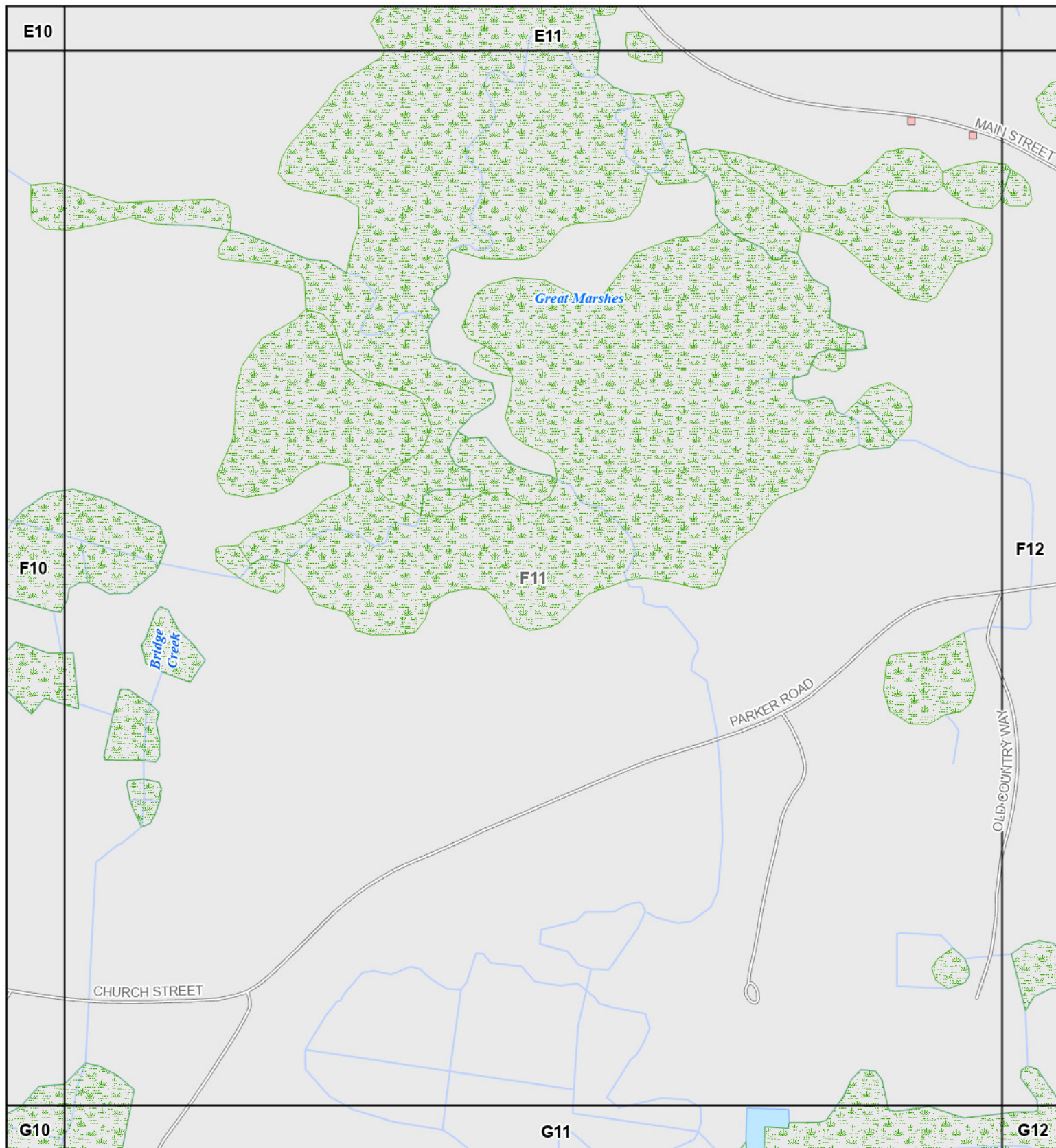
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| ▲ Outfalls | ● DOT Manhole |
| ■ Catch Basin | ■ DOT Catch Basin |
| ● Drainage Manhole | — Storm Water Gravity Drain |
| ■ Stormwater BMP | ~ Swale |
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| ✚ Interconnections | ○ Non-Urban Area |
| ▲ DOT Outfall | |

Stormwater Infrastructure Map Barnstable, MA

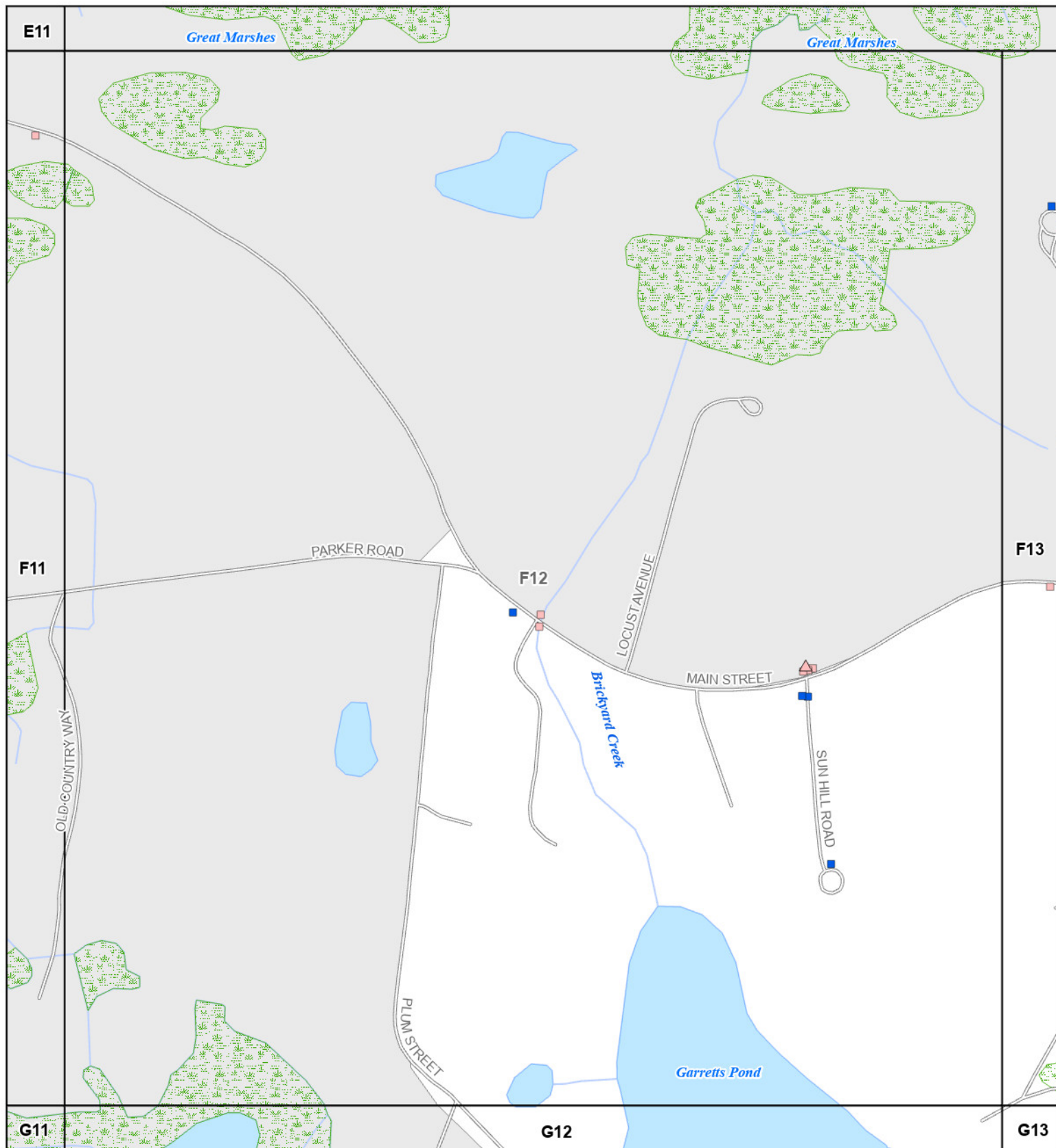
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| ● Drainage Manhole | — Storm Water Gravity Drain |
| ■ Stormwater BMP | ~ Swale |
| ★ Key Drainage Manhole | ○ Catchment |
| ✚ Interconnections | ■ Non-Urban Area |
| ▲ DOT Outfall | |

Stormwater Infrastructure Map Barnstable, MA

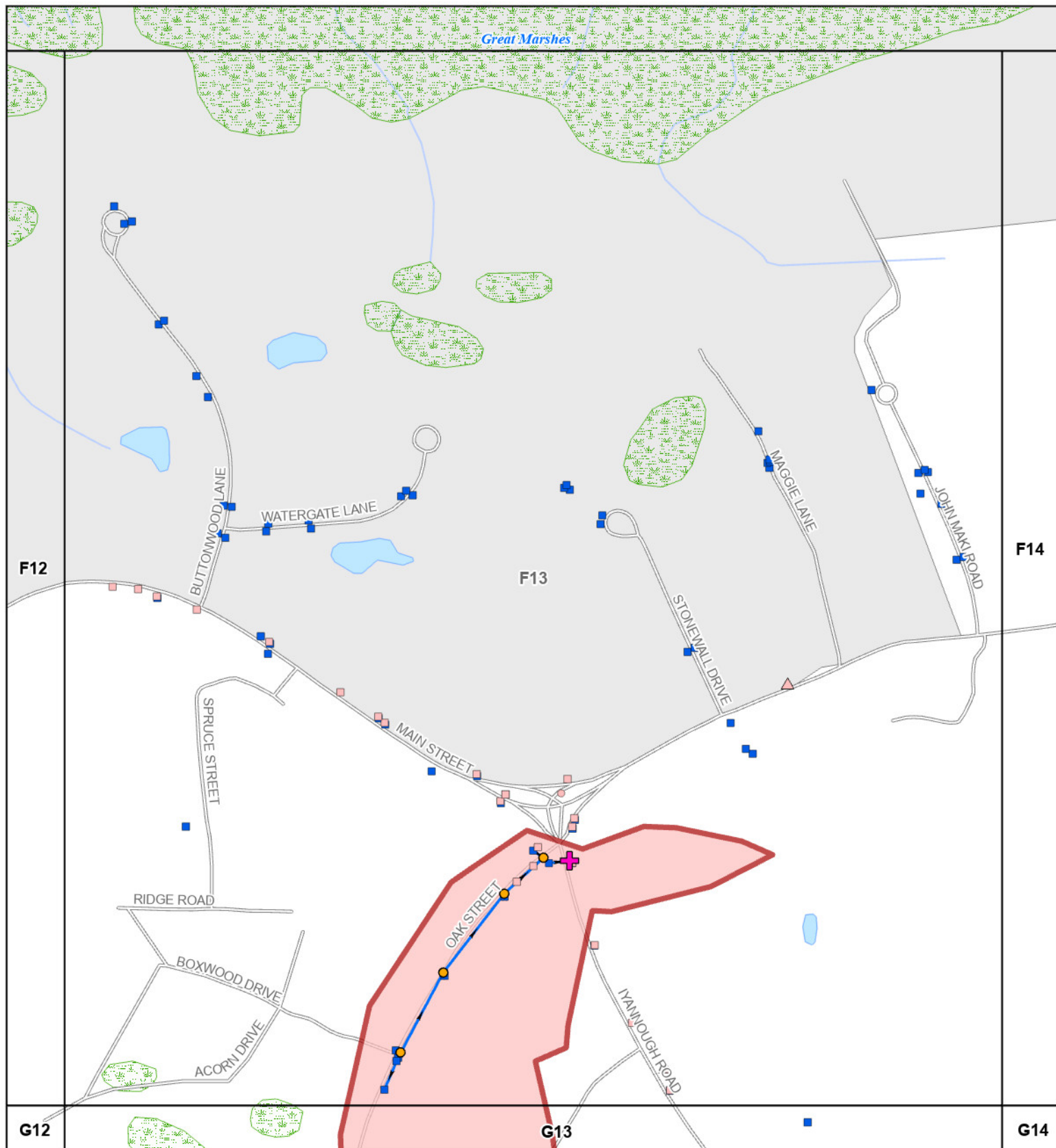
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| ● Drainage Manhole | — Storm Water Gravity Drain |
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| ★ Key Drainage Manhole | — Catchment |
| ✚ Interconnections | — Non-Urban Area |
| ▲ DOT Outfall | |

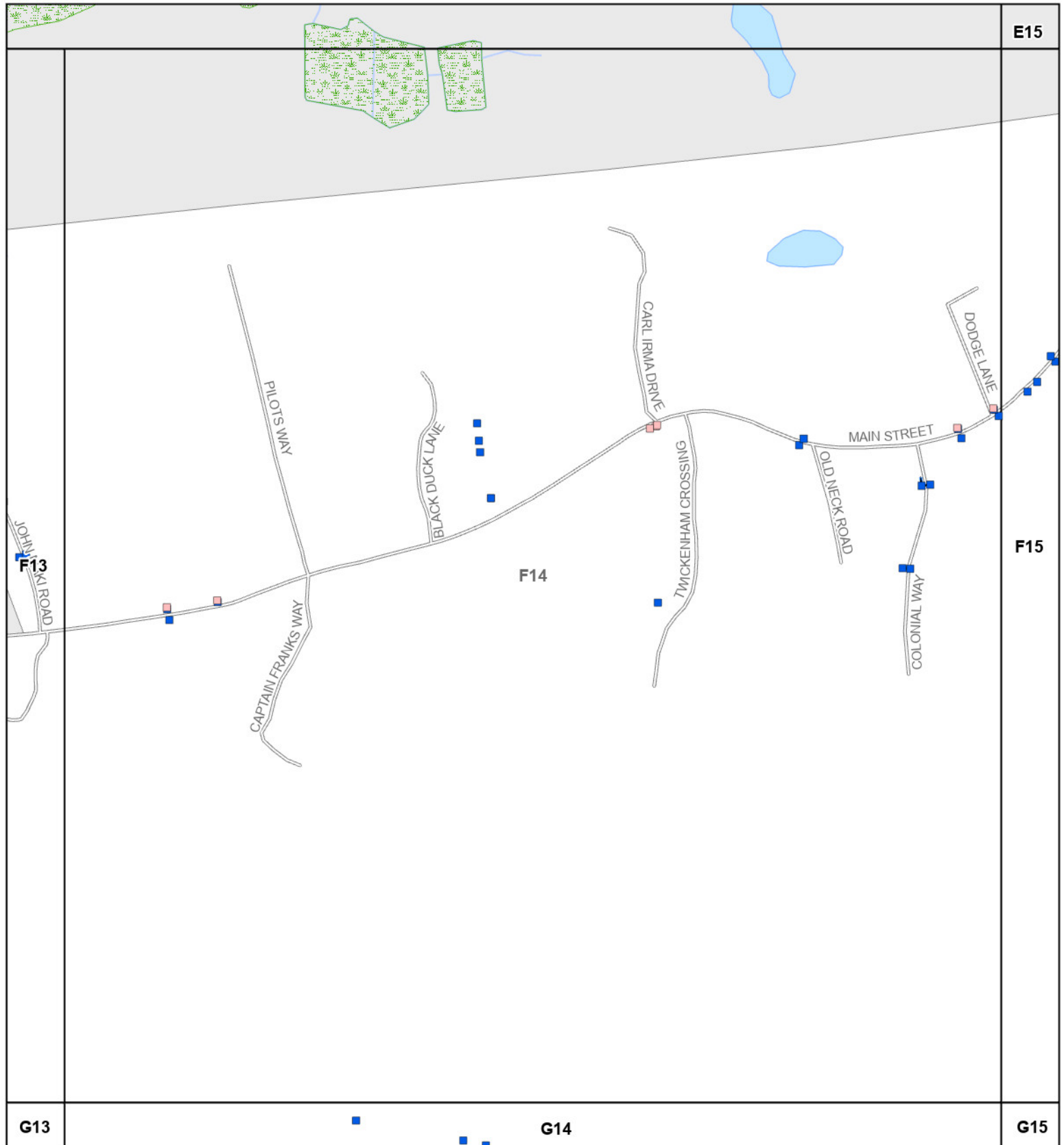
Stormwater Infrastructure Map Barnstable, MA

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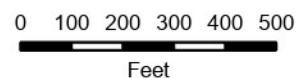


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| ▲ Outfalls | ● DOT Manhole |
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| ● Drainage Manhole | — Storm Water Gravity Drain |
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| ★ Key Drainage Manhole | — Catchment |
| ✚ Interconnections | — Non-Urban Area |
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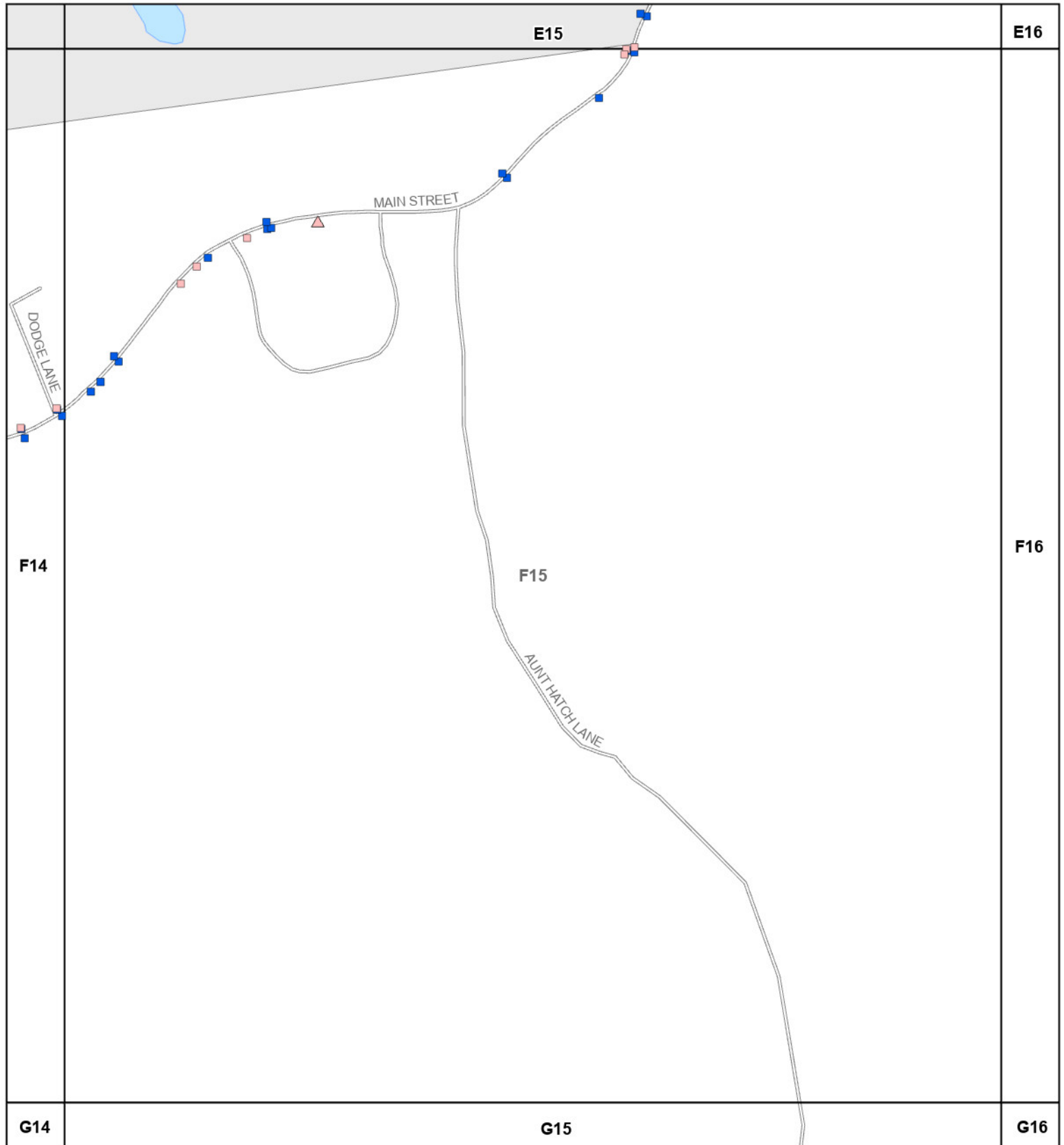
Stormwater Infrastructure Map Barnstable, MA



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| ■ Stormwater BMP | — Swale |
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| ✚ Interconnections | — Non-Urban Area |
| ▲ DOT Outfall | |

Stormwater Infrastructure Map Barnstable, MA

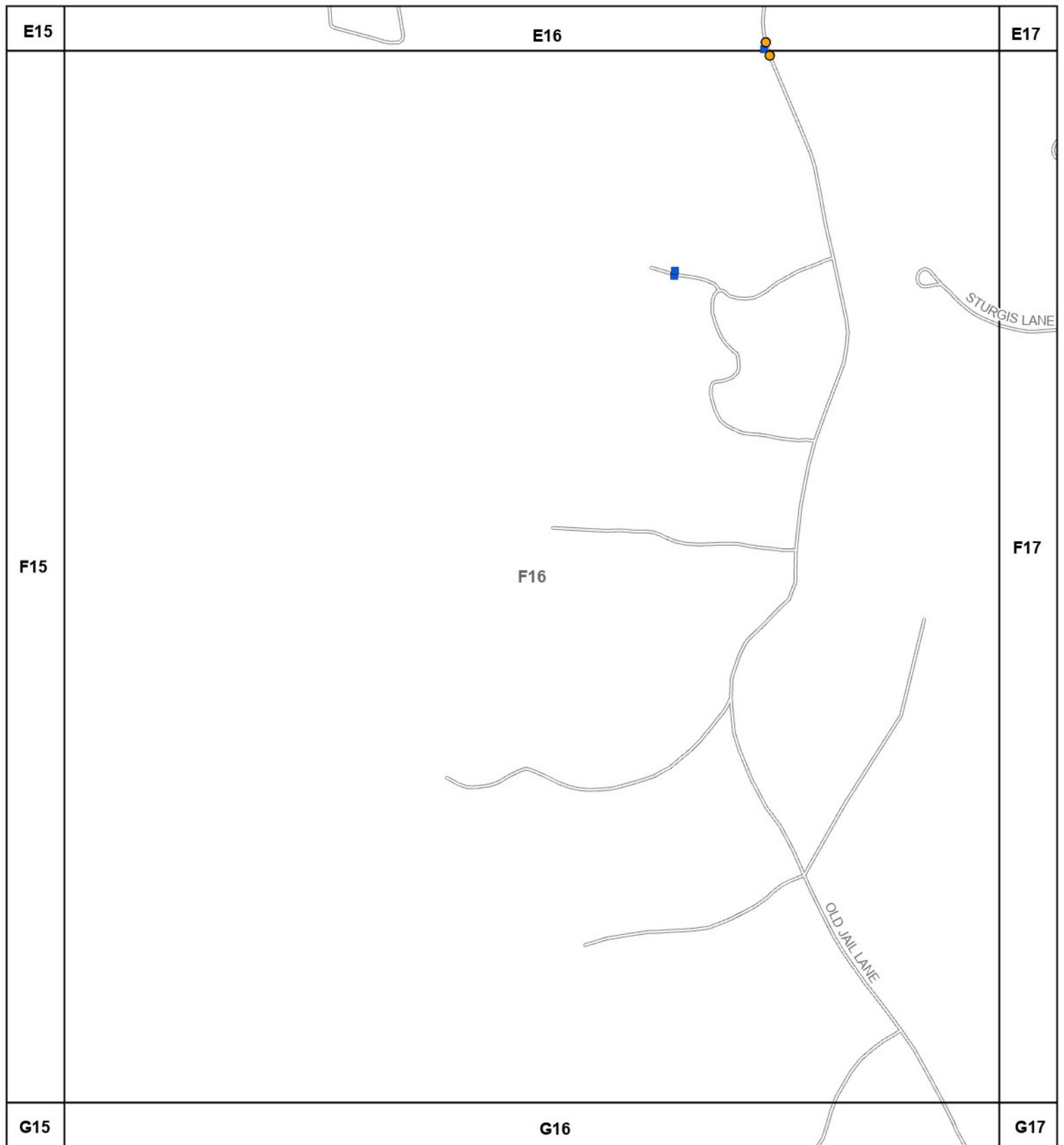
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| ● Drainage Manhole | — Storm Water Gravity Drain |
| ■ Stormwater BMP | — Swale |
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| ✚ Interconnections | — Non-Urban Area |
| ▲ DOT Outfall | |

Stormwater Infrastructure Map Barnstable, MA

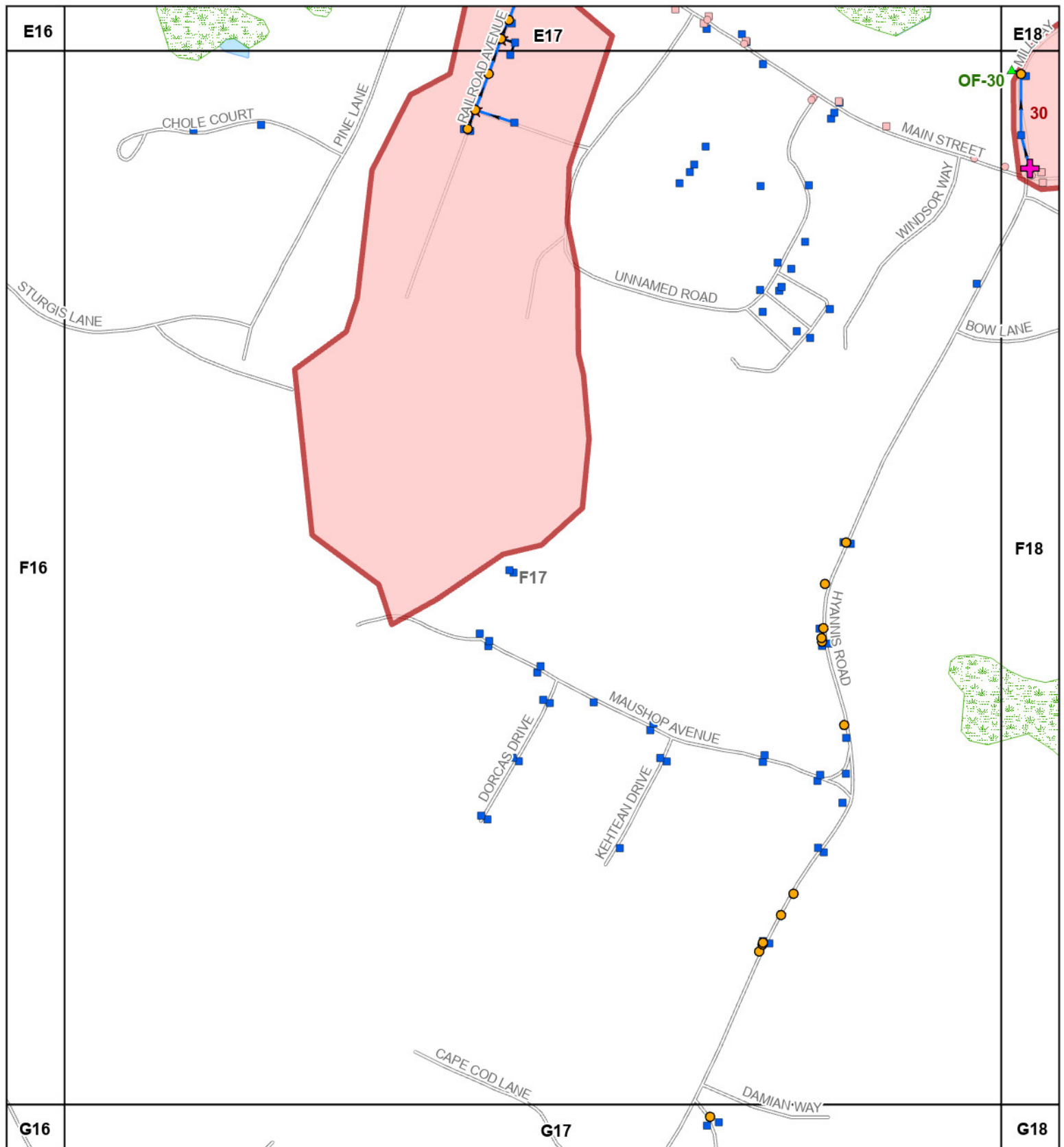
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| ▲ Outfalls | ● DOT Manhole |
| ■ Catch Basin | ■ DOT Catch Basin |
| ● Drainage Manhole | — Storm Water Gravity Drain |
| ■ Stormwater BMP | — Swale |
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| ✚ Interconnections | — Non-Urban Area |
| ▲ DOT Outfall | |

Stormwater Infrastructure Map Barnstable, MA

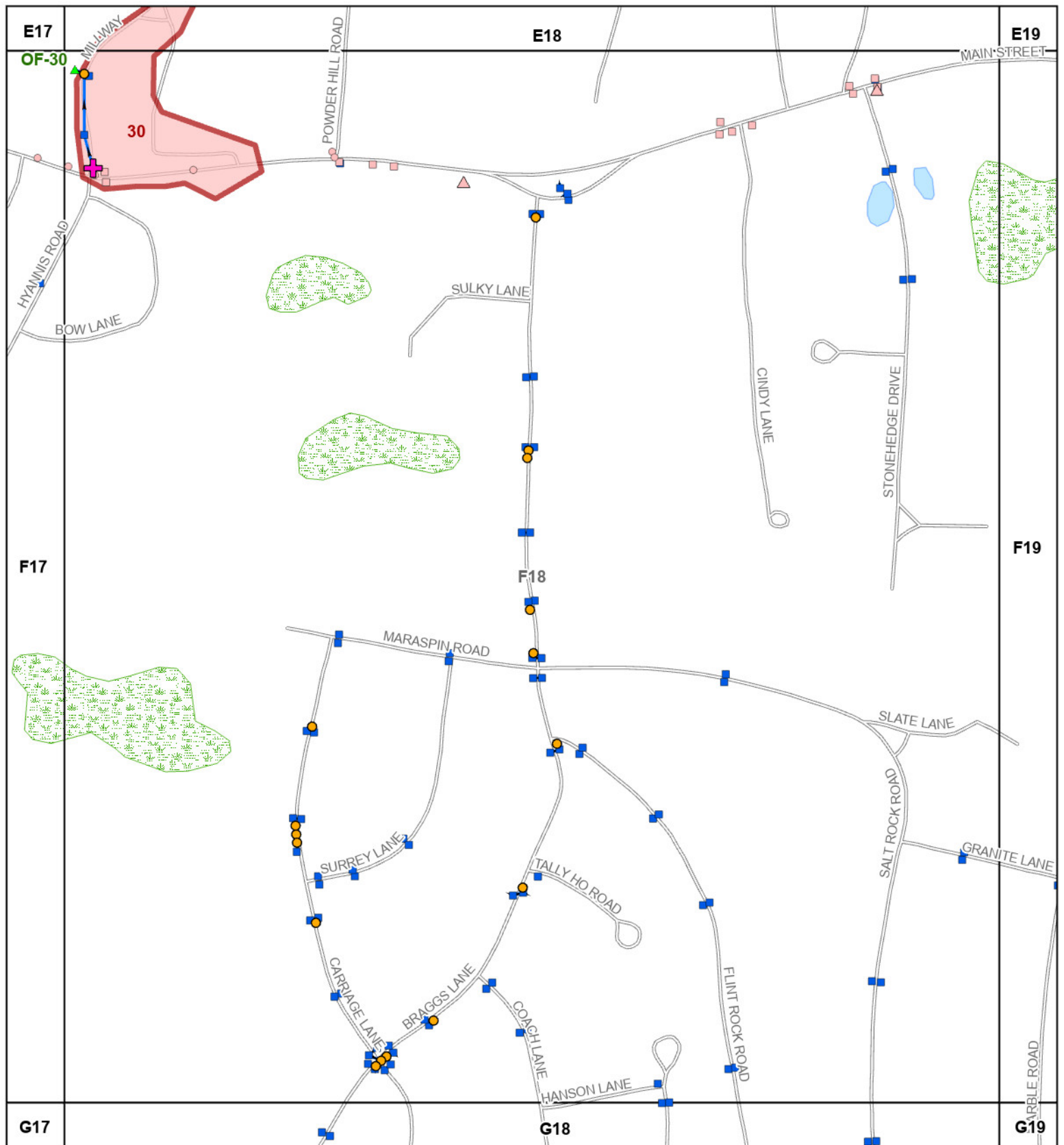
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| ● Drainage Manhole | — Storm Water Gravity Drain |
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| ✚ Interconnections | — Non-Urban Area |
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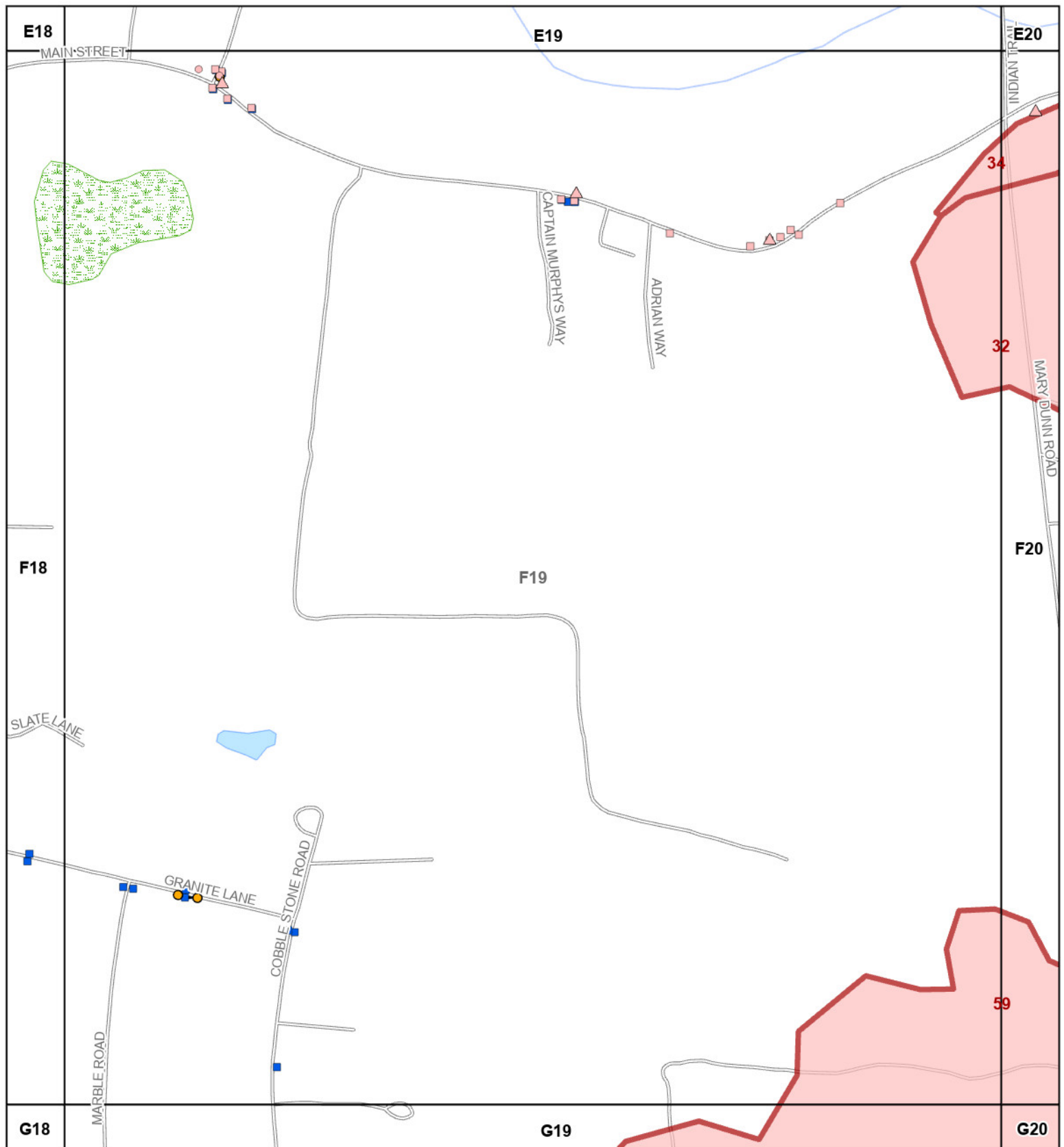
Stormwater Infrastructure Map Barnstable, MA

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| ■ Catch Basin | ■ DOT Catch Basin |
| ● Drainage Manhole | — Storm Water Gravity Drain |
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| ✚ Interconnections | — Non-Urban Area |
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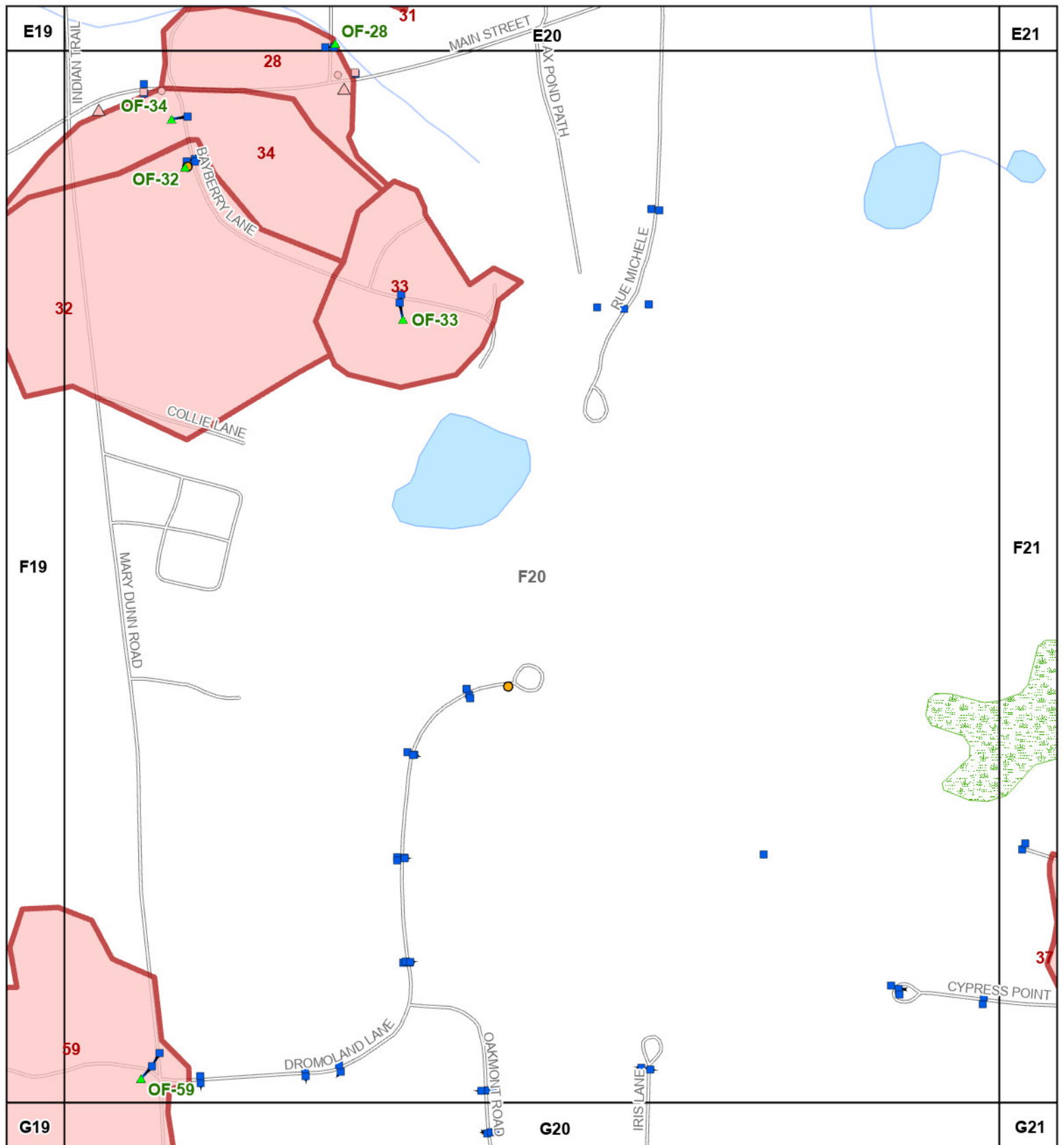
Stormwater Infrastructure Map Barnstable, MA

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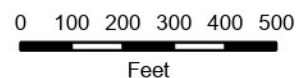


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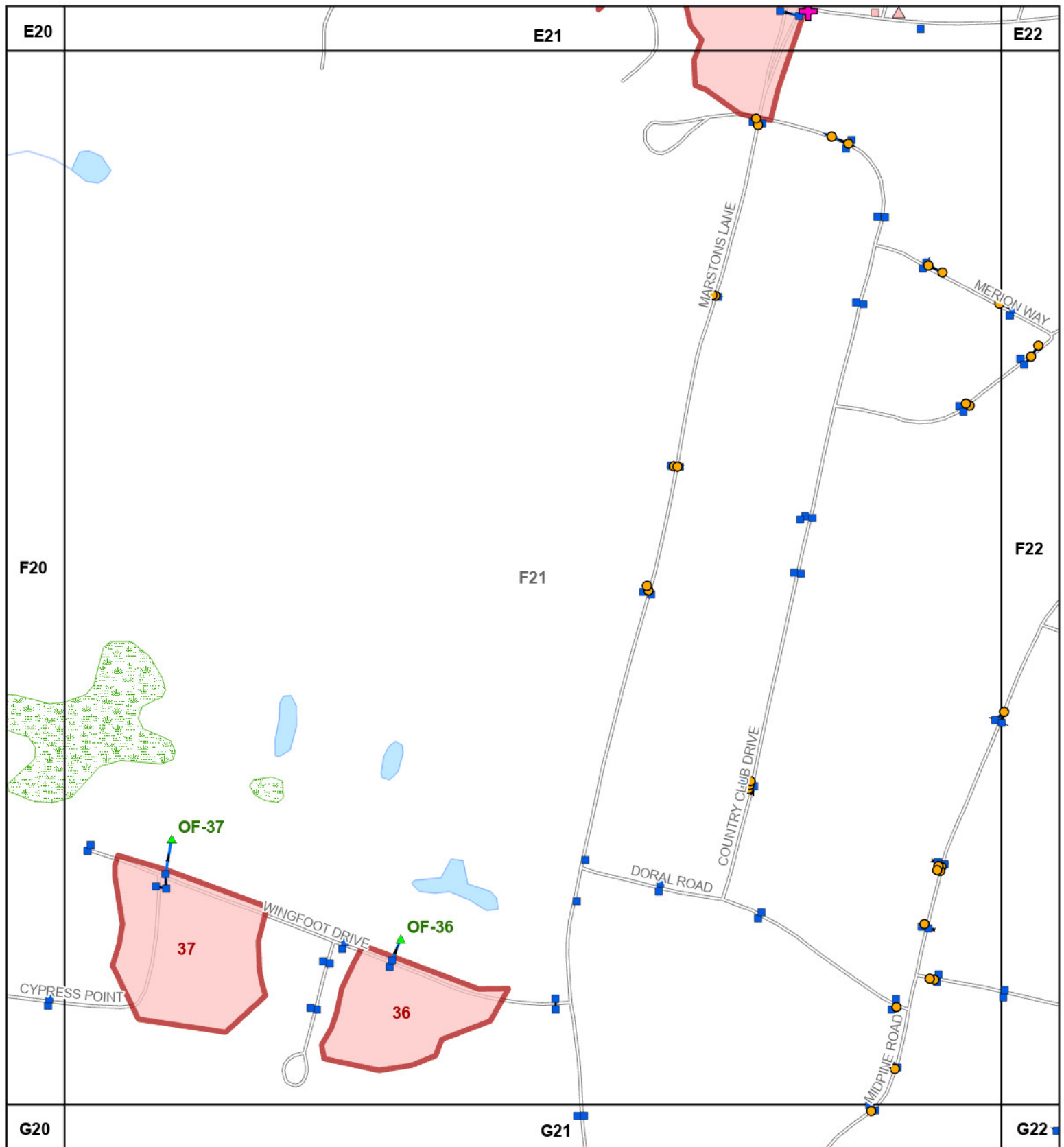


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| ▲ Outfalls | ○ DOT Manhole |
| ■ Catch Basin | ■ DOT Catch Basin |
| ● Drainage Manhole | — Storm Water Gravity Drain |
| ■ Stormwater BMP | — Swale |
| ★ Key Drainage Manhole | — Catchment |
| ✚ Interconnections | — Non-Urban Area |
| ▲ DOT Outfall | |

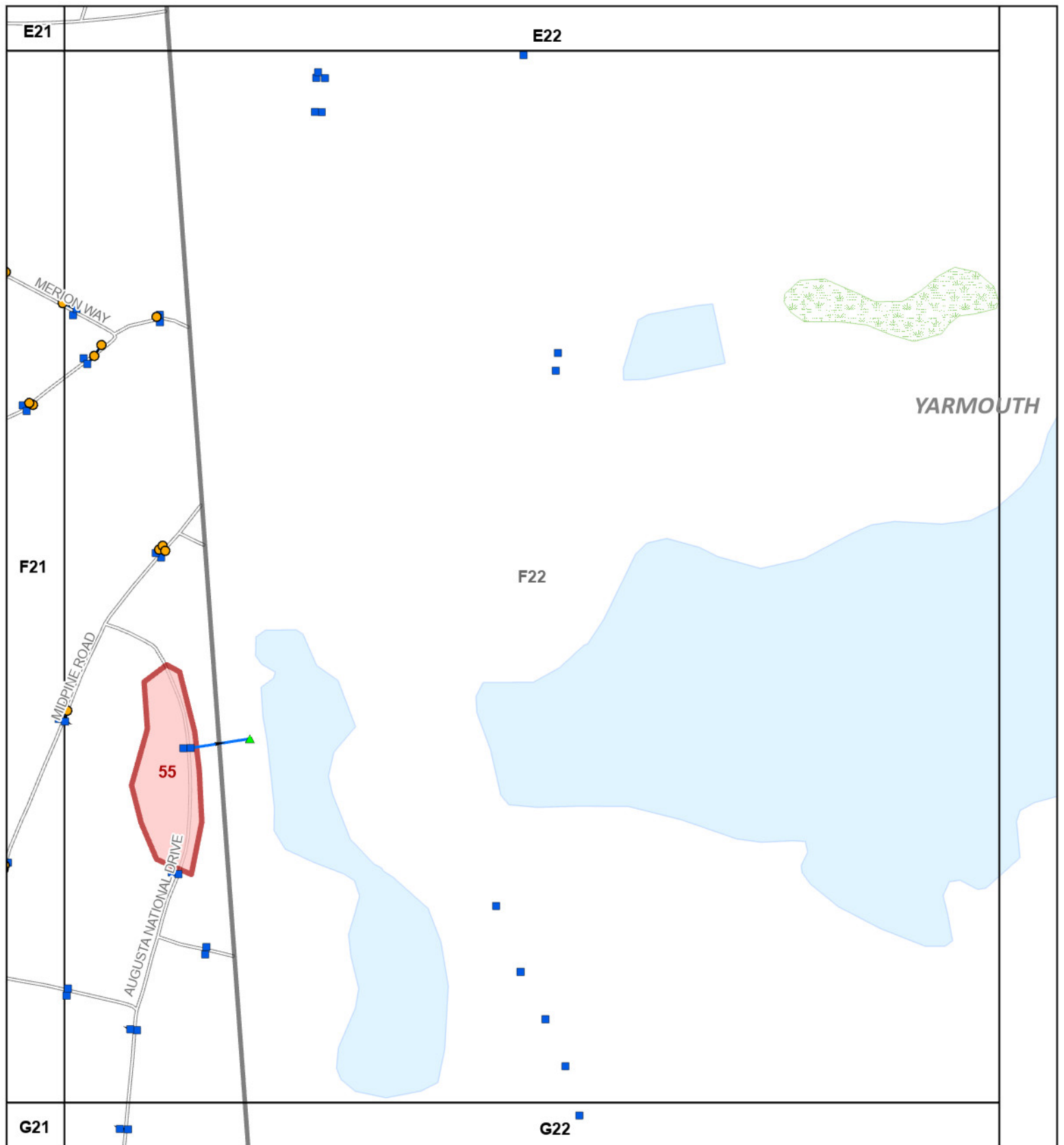
Stormwater Infrastructure Map Barnstable, MA

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| ▲ Outfalls | ○ DOT Manhole |
| ■ Catch Basin | ■ DOT Catch Basin |
| ● Drainage Manhole | — Storm Water Gravity Drain |
| ■ Stormwater BMP | — Swale |
| ★ Key Drainage Manhole | — Catchment |
| ✚ Interconnections | — Non-Urban Area |
| ▲ DOT Outfall | |

Stormwater Infrastructure Map Barnstable, MA

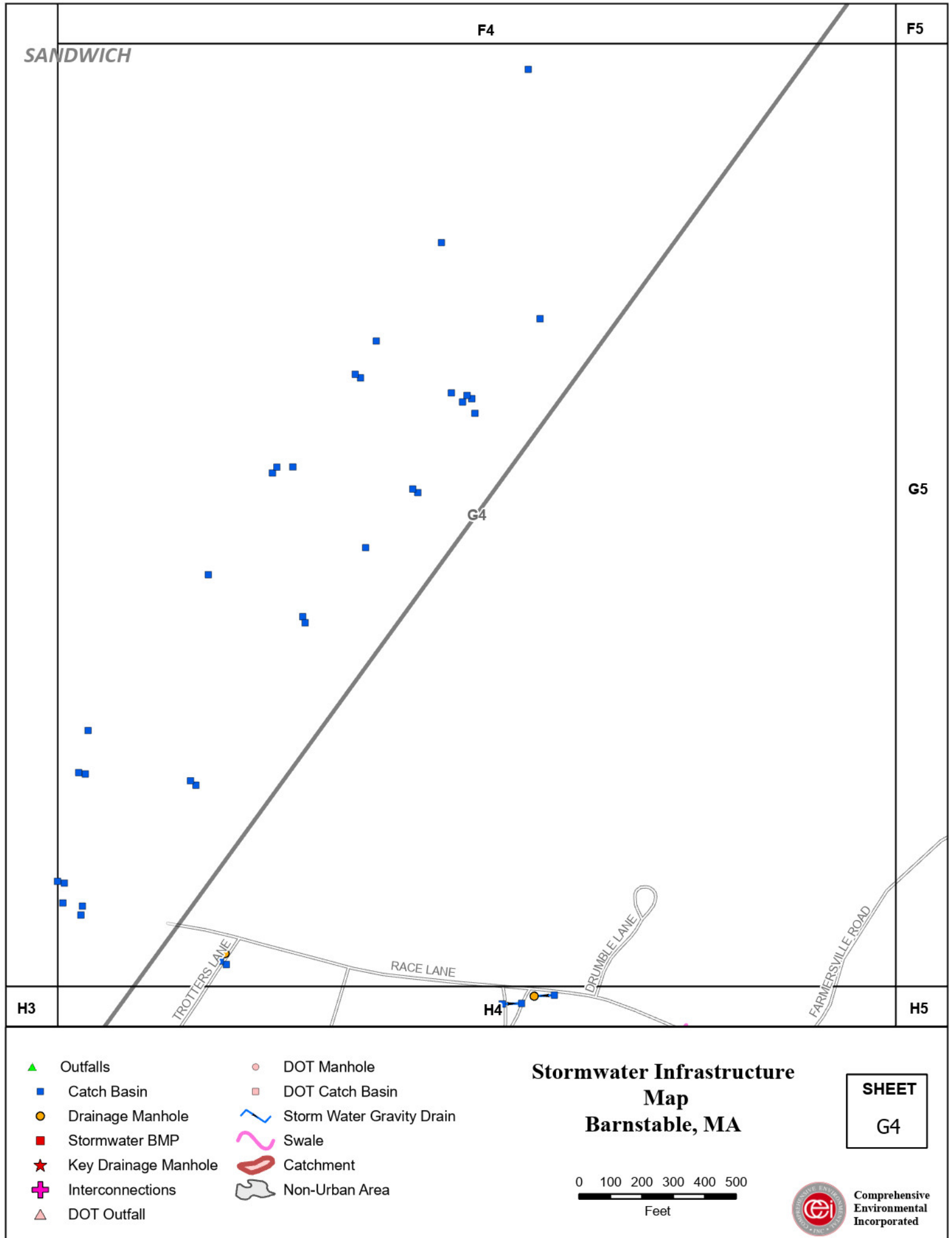
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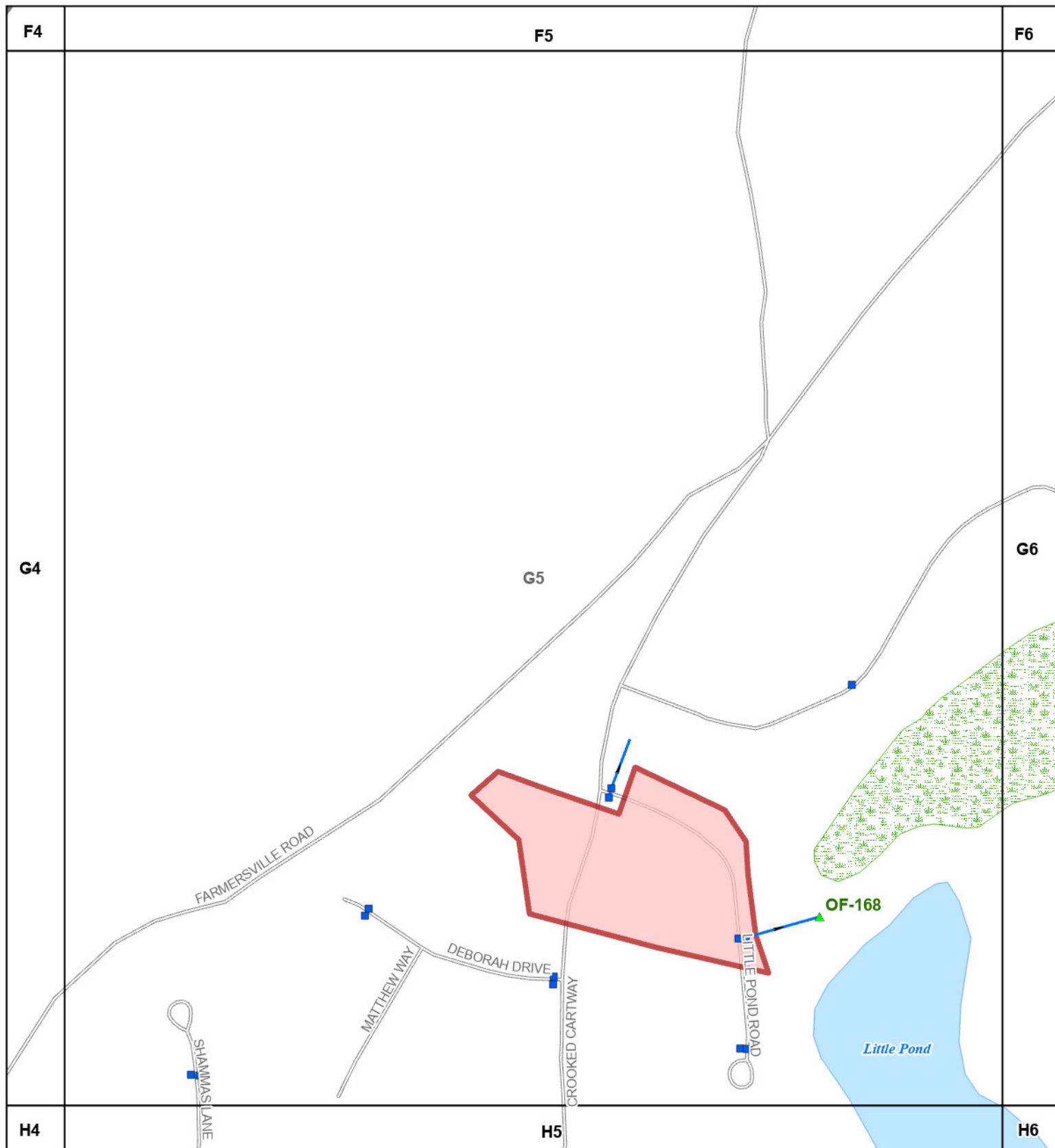
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| ▲ Outfalls | ○ DOT Manhole |
| ■ Catch Basin | ■ DOT Catch Basin |
| ● Drainage Manhole | — Storm Water Gravity Drain |
| ■ Stormwater BMP | — Swale |
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| ✚ Interconnections | — Non-Urban Area |
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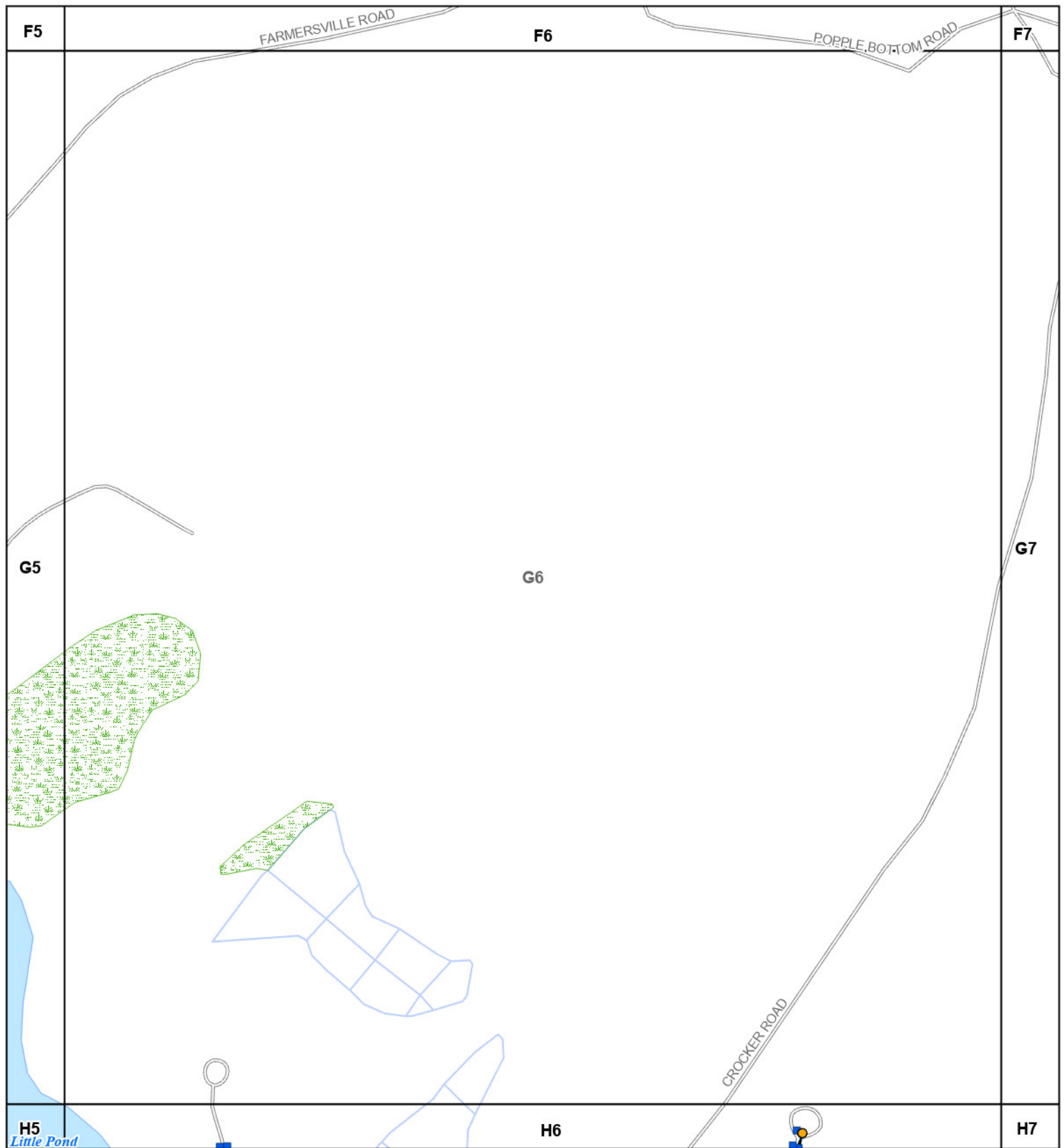
Stormwater Infrastructure Map Barnstable, MA

SHEET
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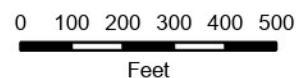


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| ▲ Outfalls | ● DOT Manhole |
| ■ Catch Basin | ■ DOT Catch Basin |
| ● Drainage Manhole | — Storm Water Gravity Drain |
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| ✚ Interconnections | — Non-Urban Area |
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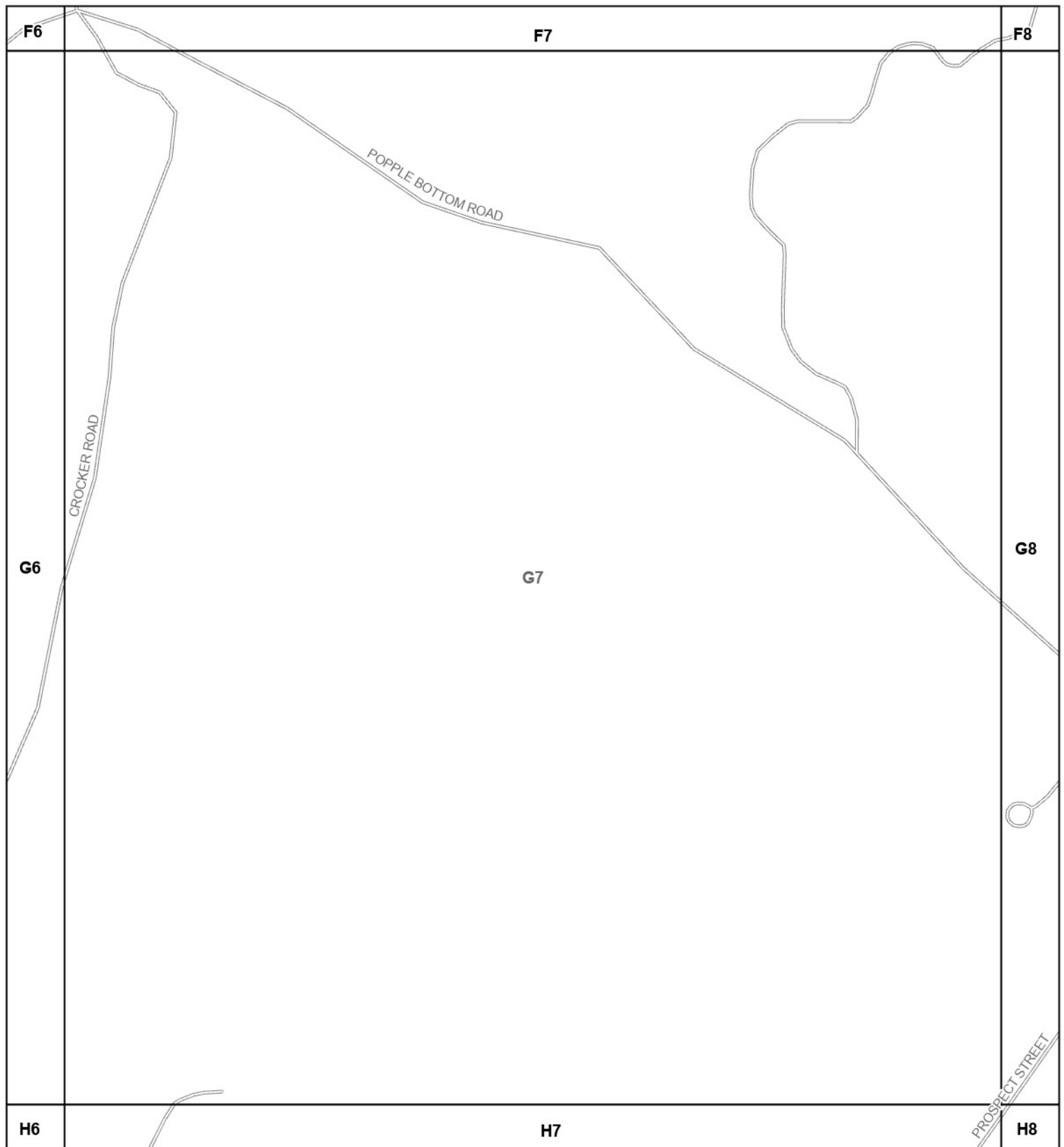
Stormwater Infrastructure Map Barnstable, MA

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Environmental
Incorporated**



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| ▲ Outfalls | ● DOT Manhole |
| ■ Catch Basin | ■ DOT Catch Basin |
| ● Drainage Manhole | — Storm Water Gravity Drain |
| ■ Stormwater BMP | — Swale |
| ★ Key Drainage Manhole | — Catchment |
| ✚ Interconnections | — Non-Urban Area |
| ▲ DOT Outfall | |

Stormwater Infrastructure Map Barnstable, MA

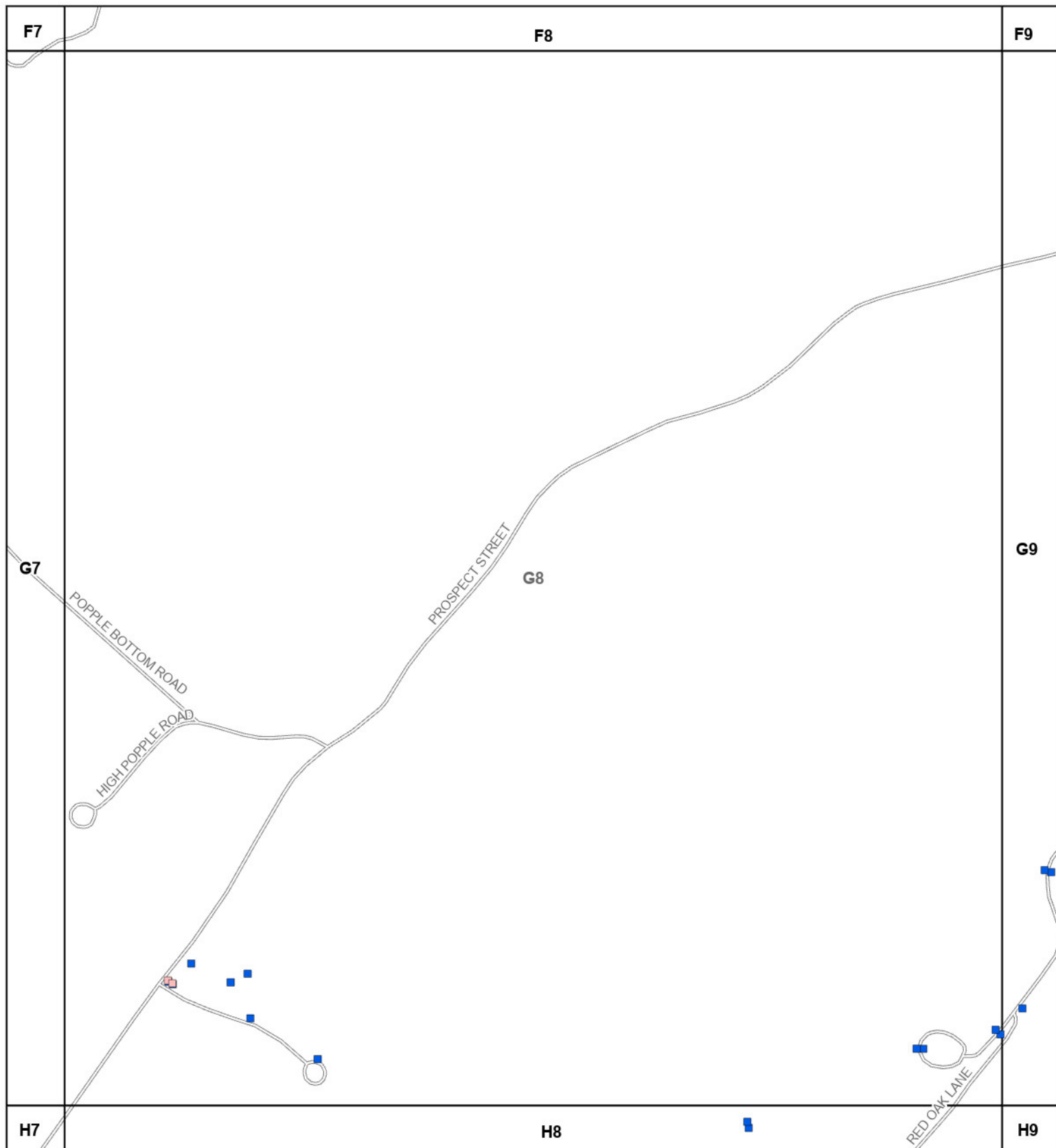
SHEET

G7

0 100 200 300 400 500
Feet



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Environmental
Incorporated



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| ▲ Outfalls | ○ DOT Manhole |
| ■ Catch Basin | ■ DOT Catch Basin |
| ● Drainage Manhole | — Storm Water Gravity Drain |
| ■ Stormwater BMP | — Swale |
| ★ Key Drainage Manhole | — Catchment |
| ✚ Interconnections | — Non-Urban Area |
| △ DOT Outfall | |

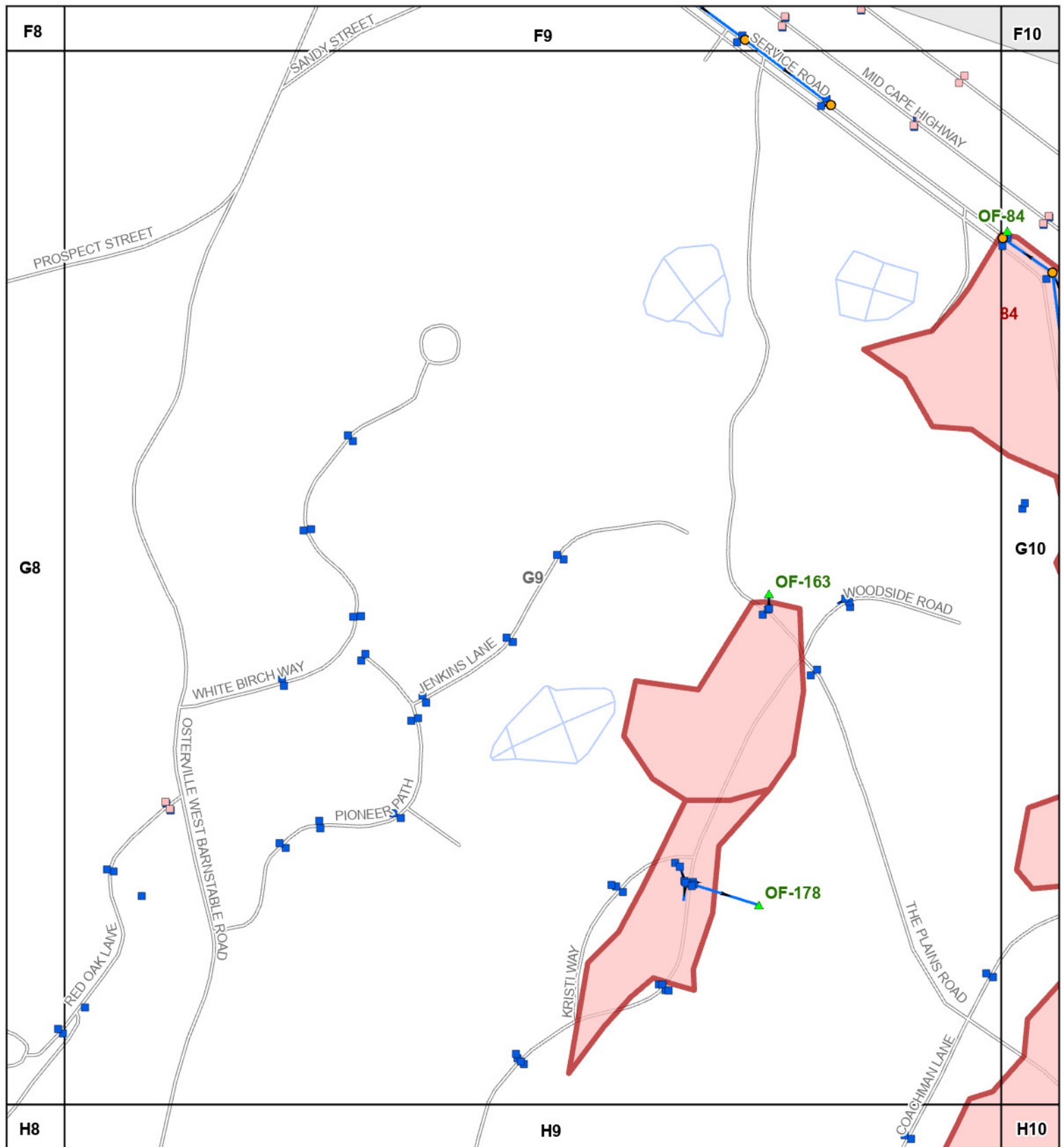
Stormwater Infrastructure Map Barnstable, MA

SHEET
G8

0 100 200 300 400 500
Feet



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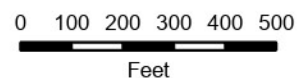


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| ▲ Outfalls | ○ DOT Manhole |
| ■ Catch Basin | ■ DOT Catch Basin |
| ● Drainage Manhole | — Storm Water Gravity Drain |
| ■ Stormwater BMP | — Swale |
| ★ Key Drainage Manhole | — Catchment |
| ✚ Interconnections | — Non-Urban Area |
| ▲ DOT Outfall | |

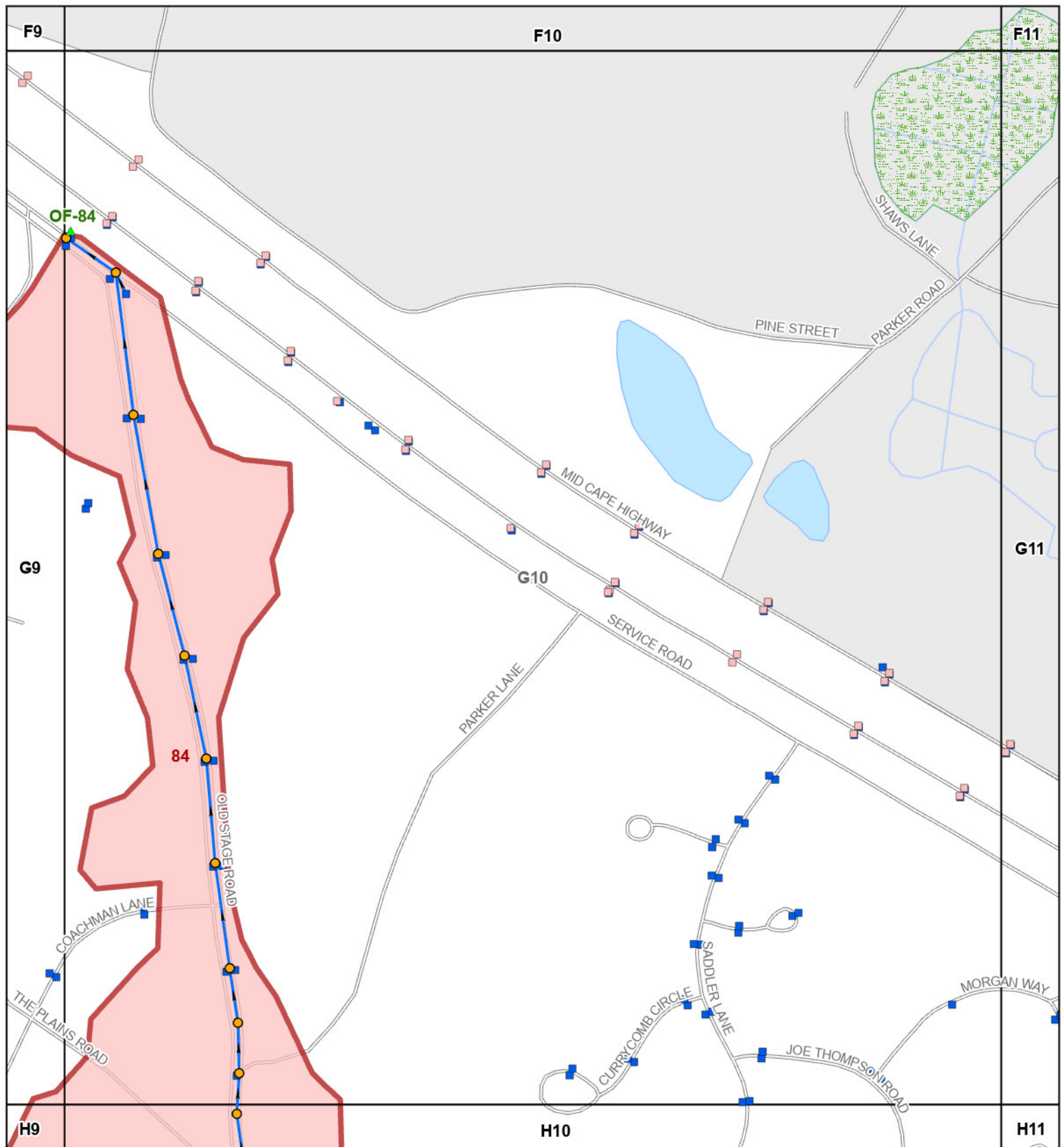
Stormwater Infrastructure Map Barnstable, MA

SHEET

G9



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Environmental
Incorporated



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| ■ Catch Basin | ■ DOT Catch Basin |
| ● Drainage Manhole | — Storm Water Gravity Drain |
| ■ Stormwater BMP | — Swale |
| ★ Key Drainage Manhole | — Catchment |
| ✚ Interconnections | — Non-Urban Area |
| ▲ DOT Outfall | |

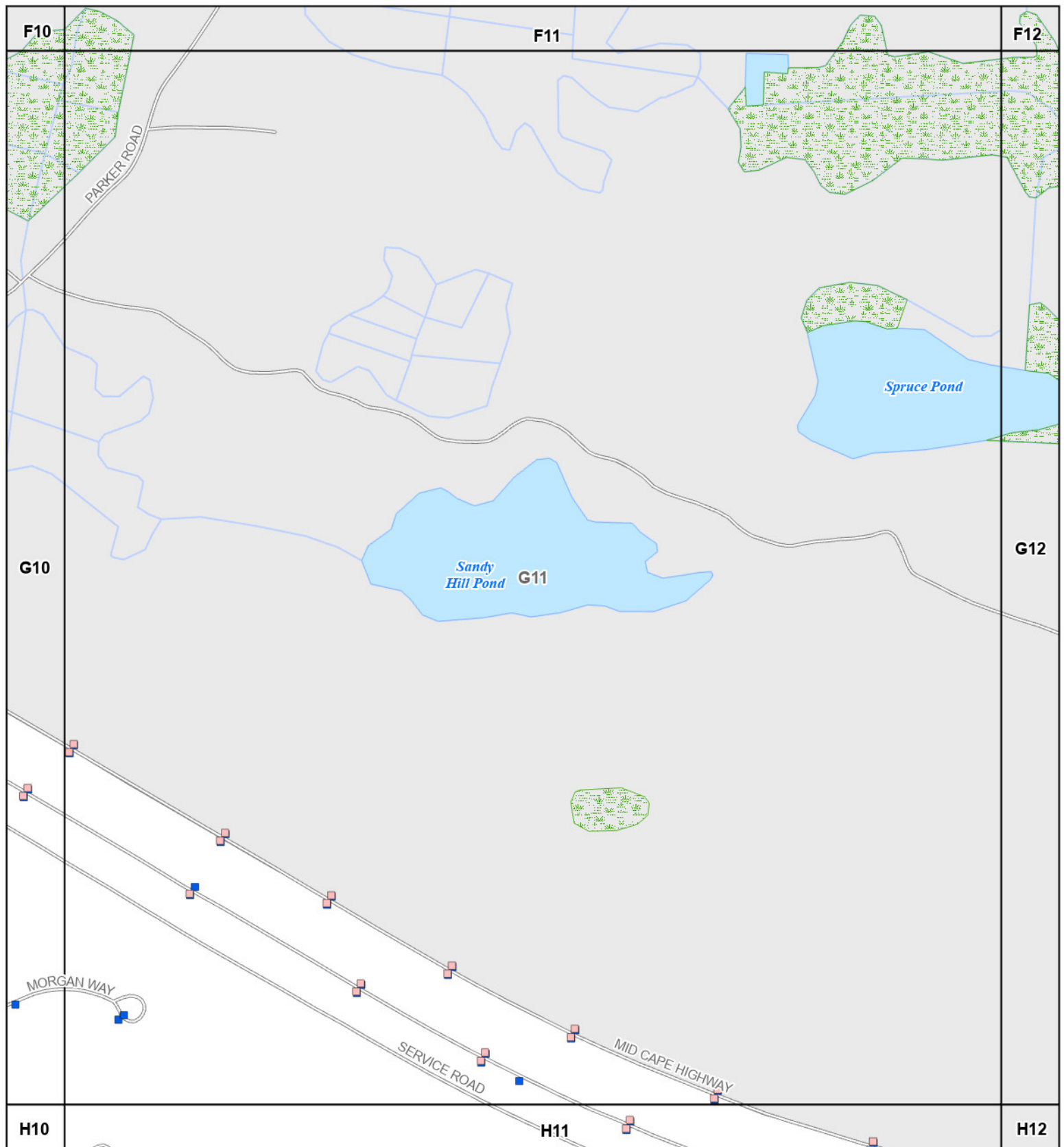
Stormwater Infrastructure Map Barnstable, MA

SHEET
G10

0 100 200 300 400 500
Feet



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| ▲ Outfalls | ○ DOT Manhole |
| ■ Catch Basin | ■ DOT Catch Basin |
| ● Drainage Manhole | — Storm Water Gravity Drain |
| ■ Stormwater BMP | — Swale |
| ★ Key Drainage Manhole | — Catchment |
| ✚ Interconnections | — Non-Urban Area |
| ▲ DOT Outfall | |

Stormwater Infrastructure Map Barnstable, MA

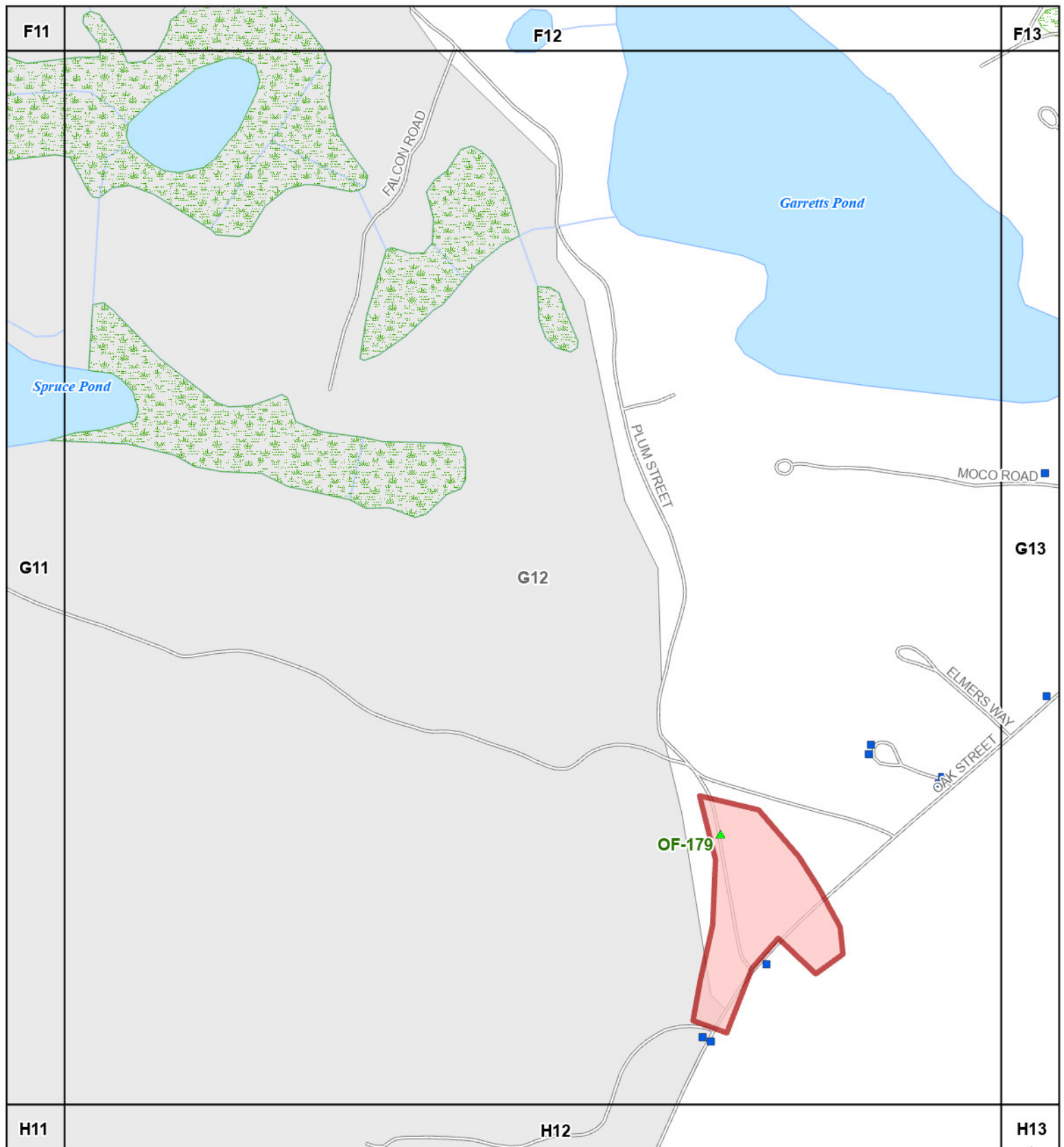
SHEET

G11

0 100 200 300 400 500
Feet



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Environmental
Incorporated



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| ▲ Outfalls | ○ DOT Manhole |
| ■ Catch Basin | ■ DOT Catch Basin |
| ● Drainage Manhole | — Storm Water Gravity Drain |
| ■ Stormwater BMP | — Swale |
| ★ Key Drainage Manhole | — Catchment |
| ✚ Interconnections | — Non-Urban Area |
| ▲ DOT Outfall | |

Stormwater Infrastructure Map Barnstable, MA

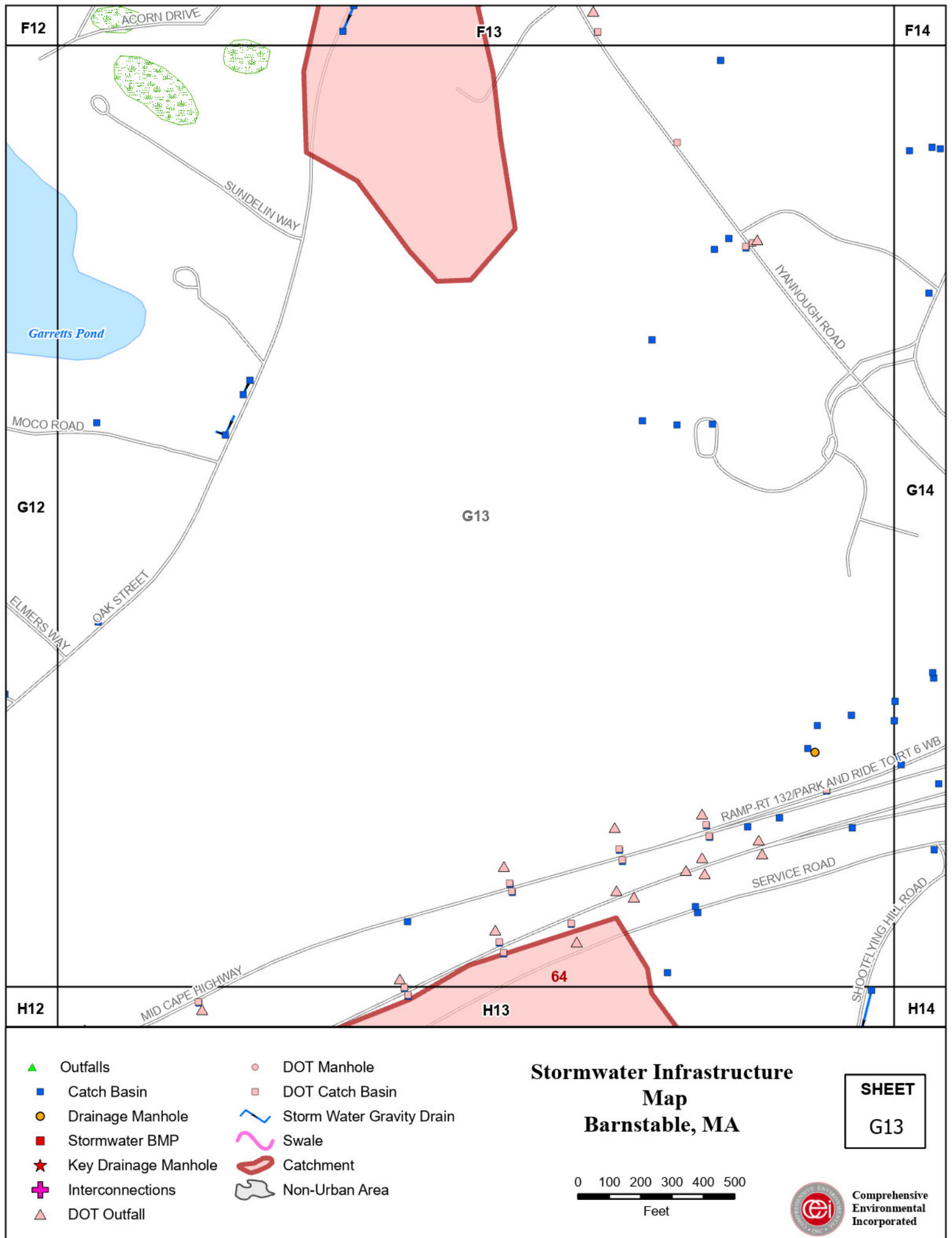
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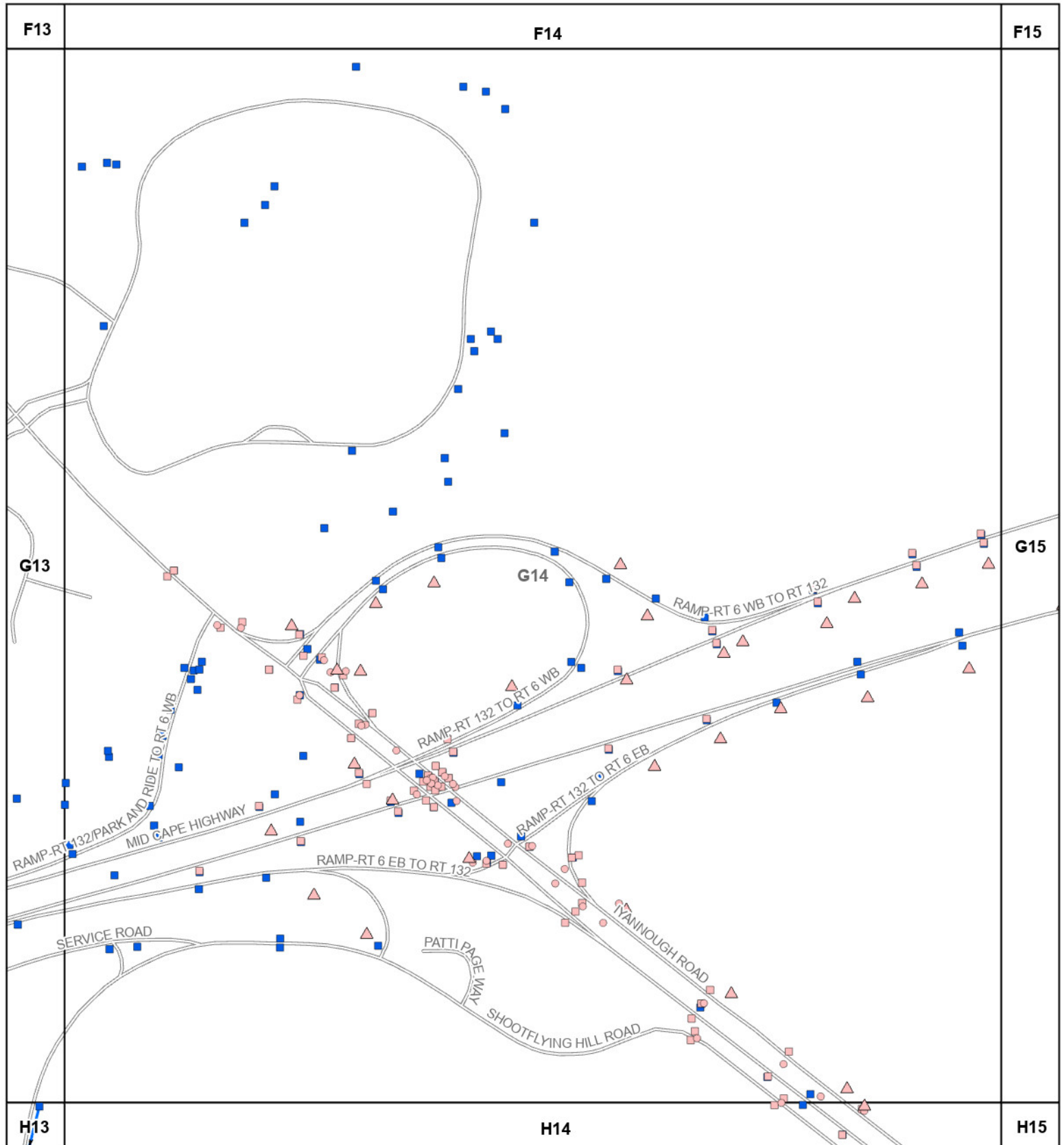
G12

0 100 200 300 400 500
Feet



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Environmental
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| ▲ Outfalls | ● DOT Manhole |
| ■ Catch Basin | ■ DOT Catch Basin |
| ● Drainage Manhole | — Storm Water Gravity Drain |
| ■ Stormwater BMP | — Swale |
| ★ Key Drainage Manhole | — Catchment |
| ✚ Interconnections | — Non-Urban Area |
| ▲ DOT Outfall | |

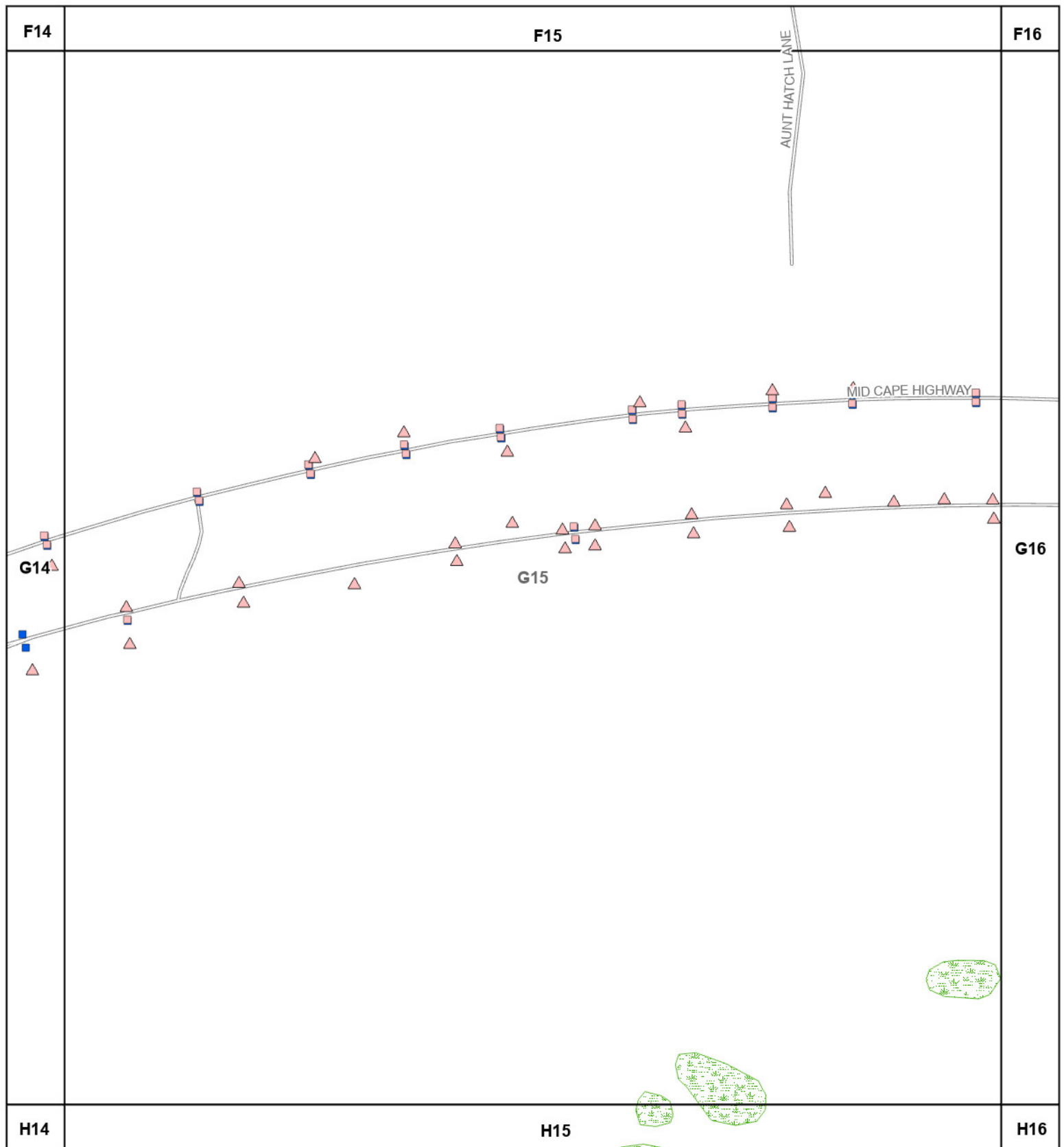
Stormwater Infrastructure Map Barnstable, MA

SHEET
G14

0 100 200 300 400 500
Feet



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| ▲ Outfalls | ● DOT Manhole |
| ■ Catch Basin | ■ DOT Catch Basin |
| ● Drainage Manhole | — Storm Water Gravity Drain |
| ■ Stormwater BMP | — Swale |
| ★ Key Drainage Manhole | — Catchment |
| ✚ Interconnections | — Non-Urban Area |
| ▲ DOT Outfall | |

Stormwater Infrastructure Map Barnstable, MA

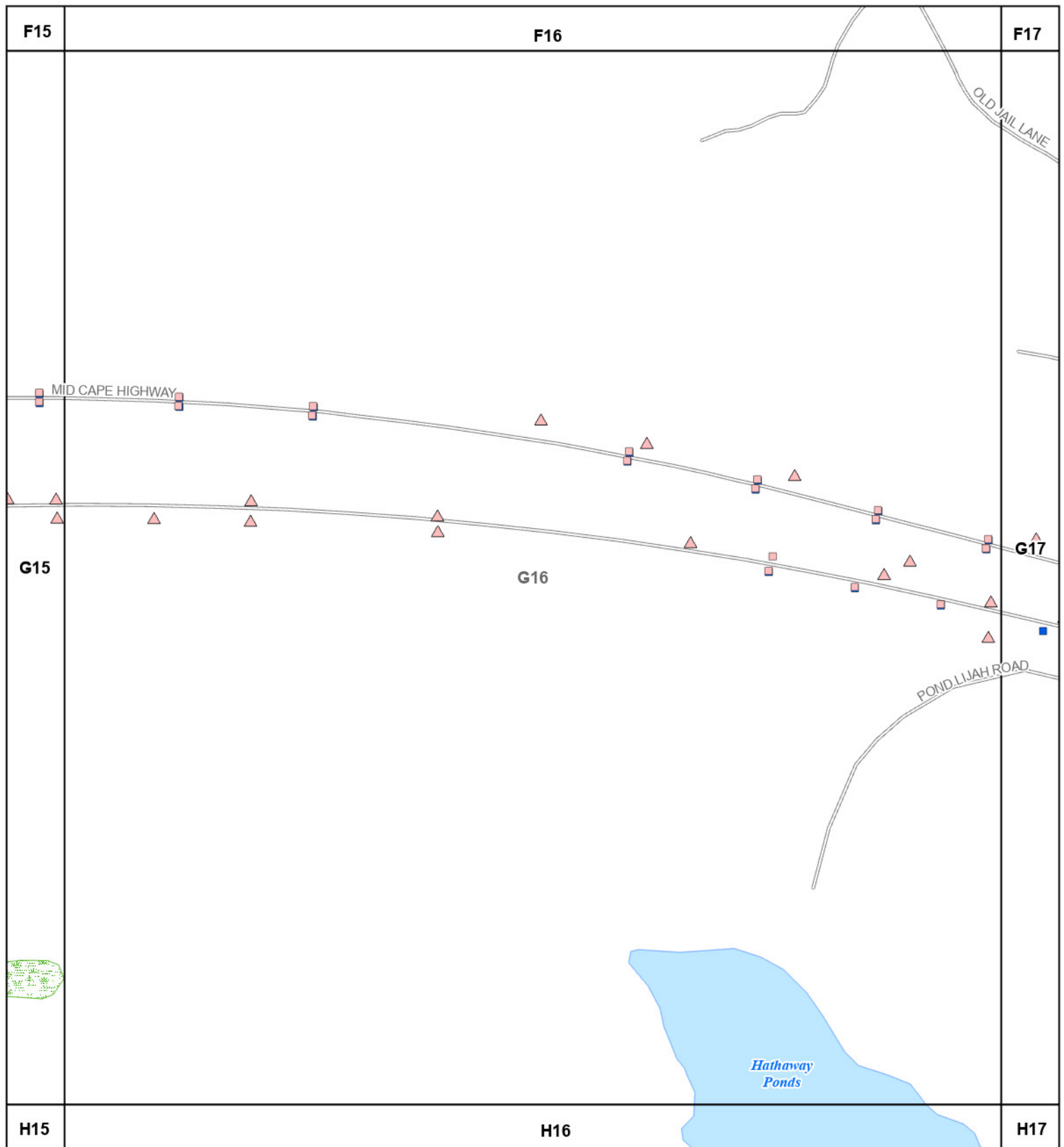
SHEET

G15

0 100 200 300 400 500
Feet



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Environmental
Incorporated



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| ▲ Outfalls | ○ DOT Manhole |
| ■ Catch Basin | ■ DOT Catch Basin |
| ● Drainage Manhole | — Storm Water Gravity Drain |
| ■ Stormwater BMP | ~ Swale |
| ★ Key Drainage Manhole | ⬮ Catchment |
| ✚ Interconnections | ☁ Non-Urban Area |
| △ DOT Outfall | |

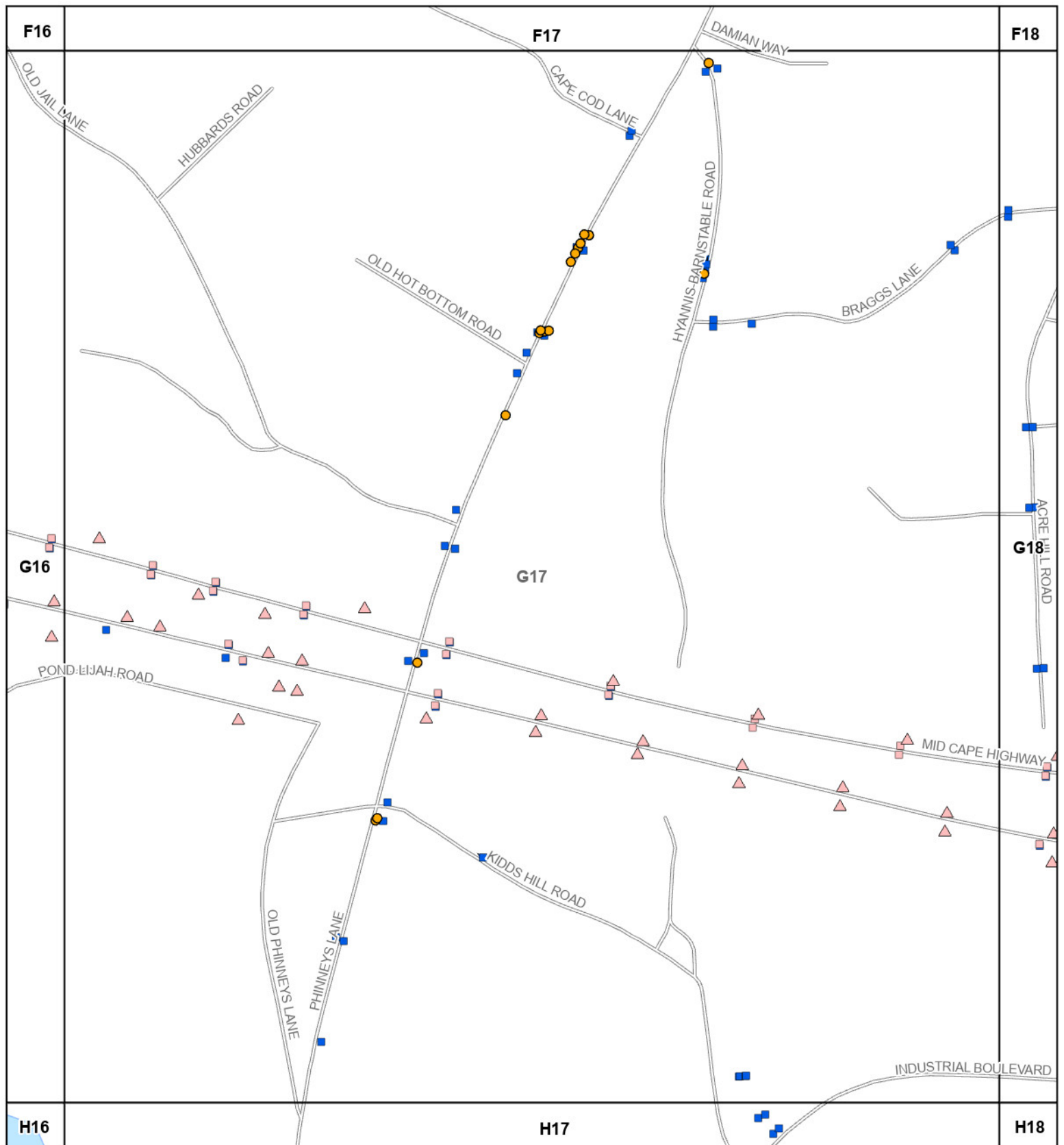
Stormwater Infrastructure Map Barnstable, MA

SHEET
G16

0 100 200 300 400 500
Feet



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| ▲ Outfalls | ● DOT Manhole |
| ■ Catch Basin | ■ DOT Catch Basin |
| ● Drainage Manhole | — Storm Water Gravity Drain |
| ■ Stormwater BMP | — Swale |
| ★ Key Drainage Manhole | — Catchment |
| ✚ Interconnections | — Non-Urban Area |
| ▲ DOT Outfall | |

Stormwater Infrastructure Map Barnstable, MA

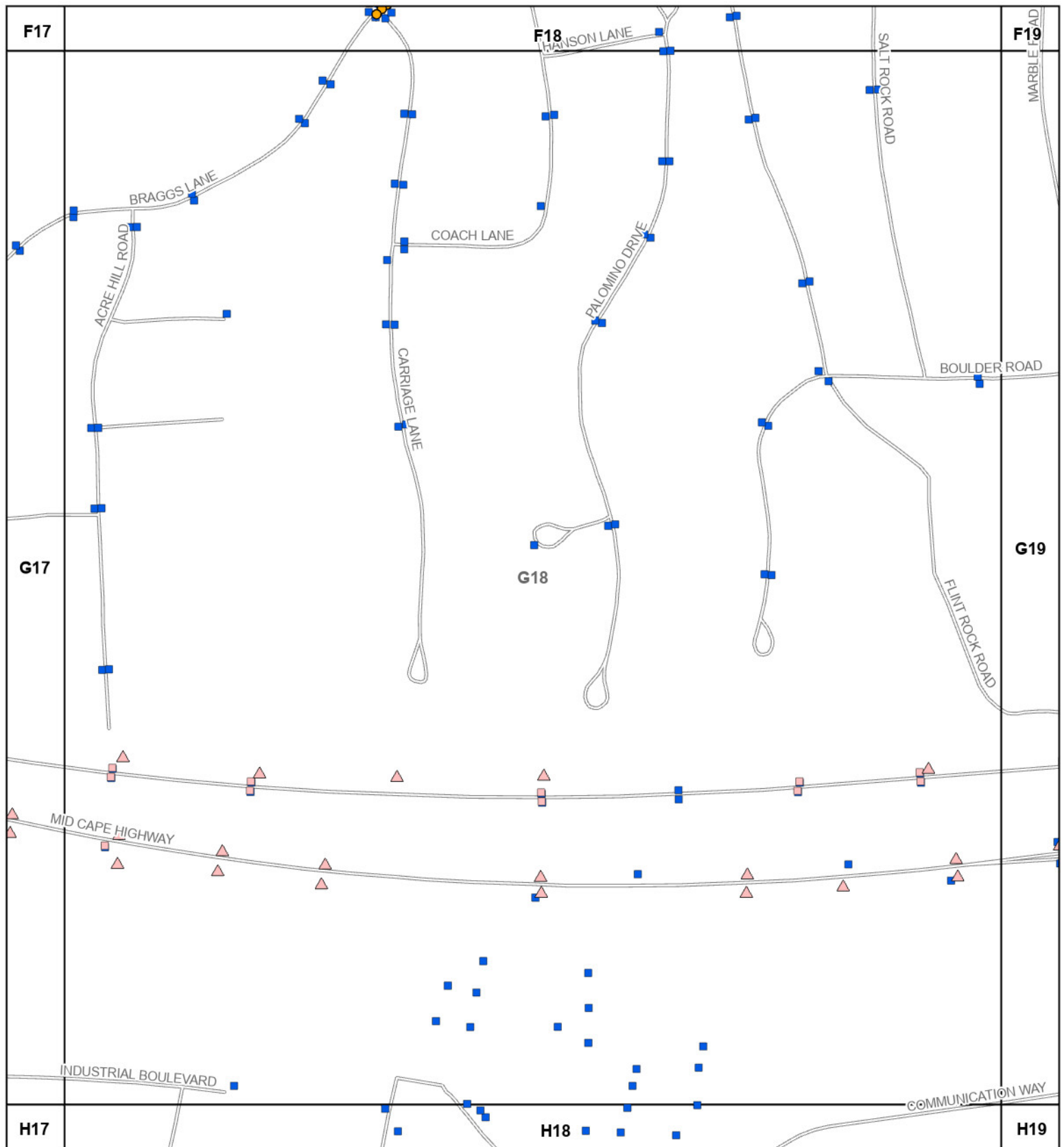
SHEET

G17

0 100 200 300 400 500
Feet



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| ▲ Outfalls | ○ DOT Manhole |
| ■ Catch Basin | ■ DOT Catch Basin |
| ● Drainage Manhole | — Storm Water Gravity Drain |
| ■ Stormwater BMP | — Swale |
| ★ Key Drainage Manhole | — Catchment |
| ✚ Interconnections | — Non-Urban Area |
| ▲ DOT Outfall | |

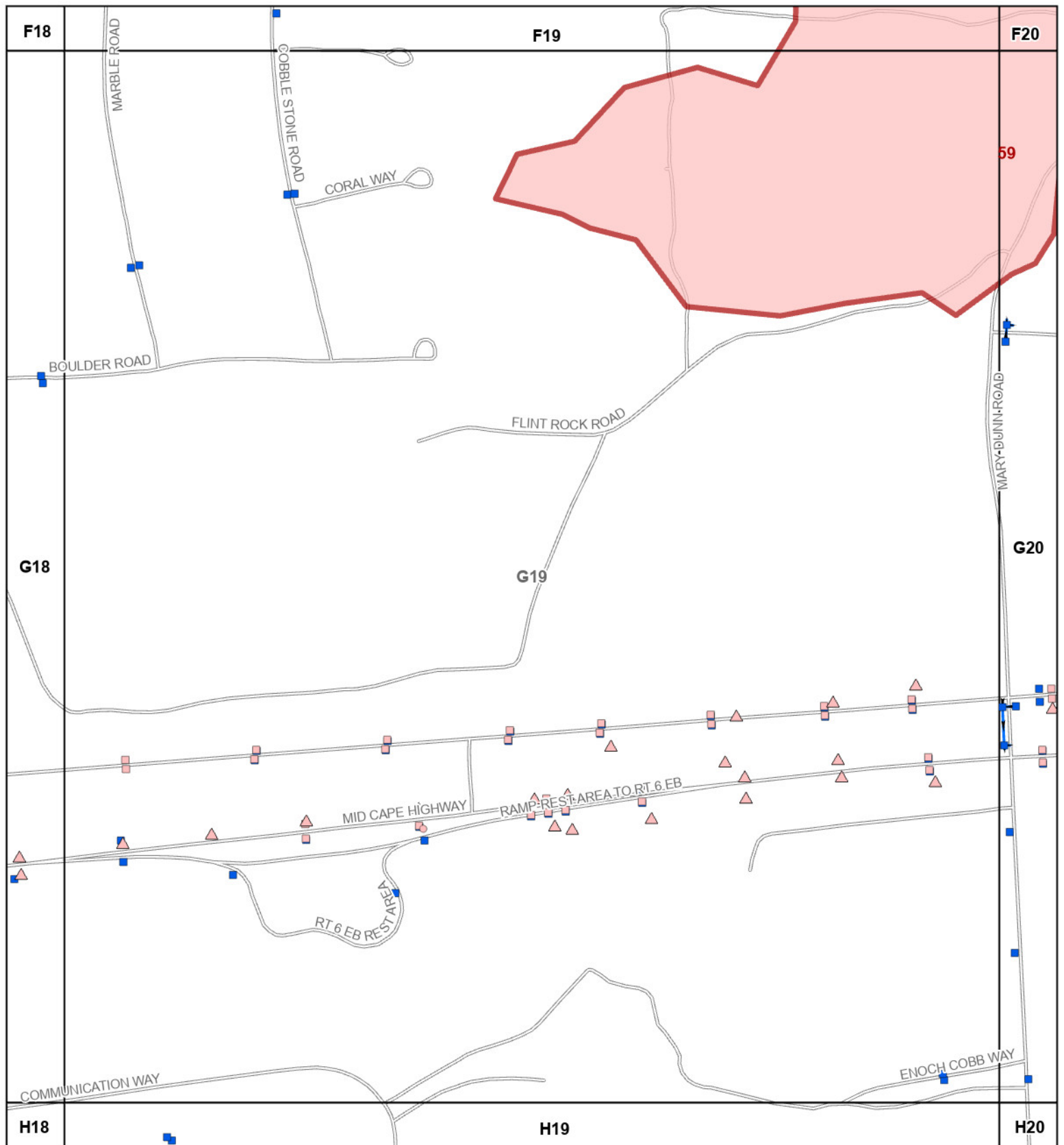
Stormwater Infrastructure Map Barnstable, MA

SHEET
G18

0 100 200 300 400 500
Feet



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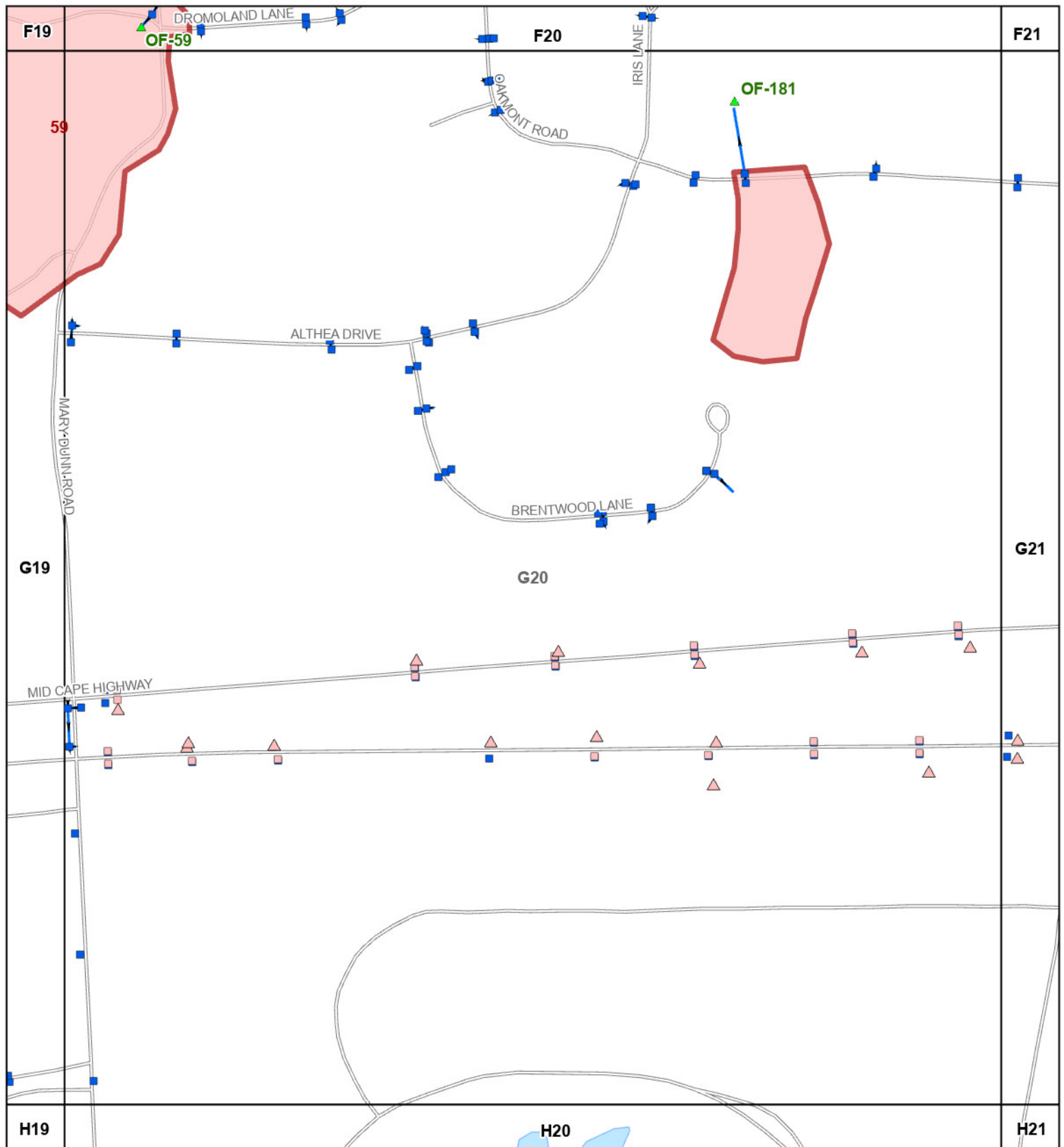
Stormwater Infrastructure Map Barnstable, MA

SHEET
G19

0 100 200 300 400 500
Feet



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| ▲ Outfalls | ● DOT Manhole |
| ■ Catch Basin | ■ DOT Catch Basin |
| ● Drainage Manhole | — Storm Water Gravity Drain |
| ■ Stormwater BMP | — Swale |
| ★ Key Drainage Manhole | — Catchment |
| ✚ Interconnections | — Non-Urban Area |
| ▲ DOT Outfall | |

Stormwater Infrastructure Map Barnstable, MA

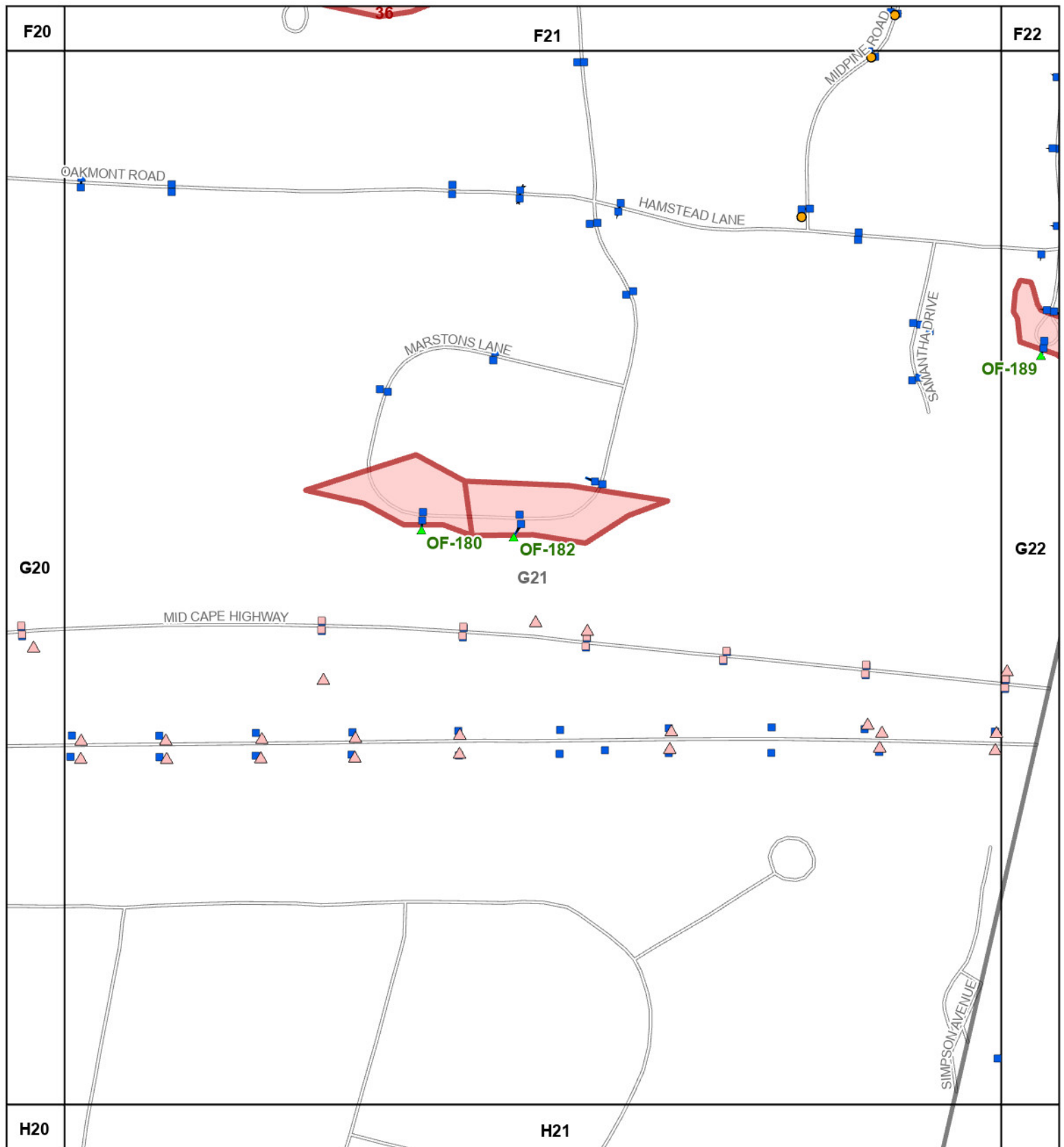
SHEET

G20

0 100 200 300 400 500
Feet



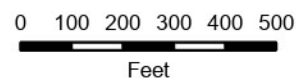
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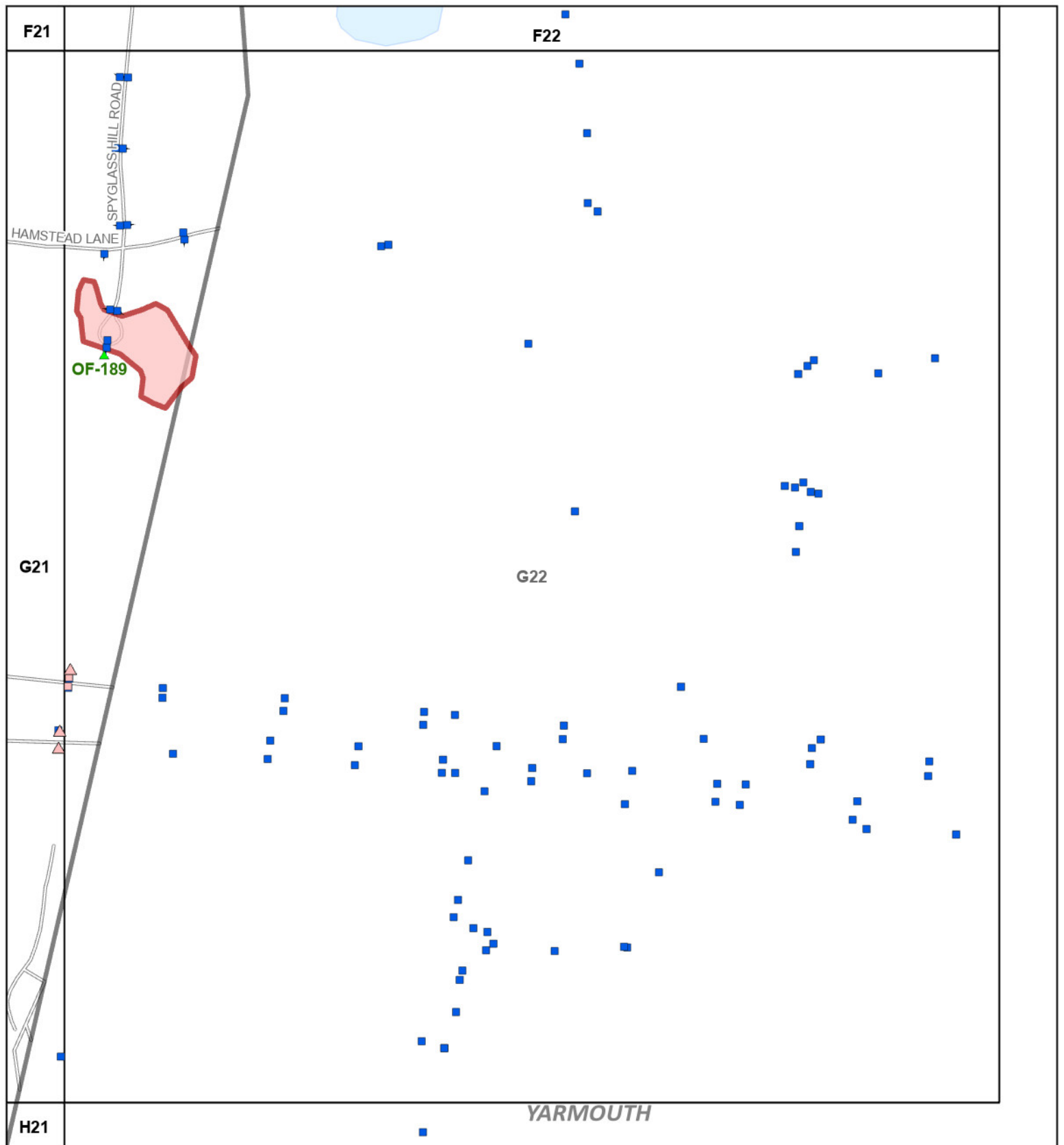
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| ▲ Outfalls | ○ DOT Manhole |
| ■ Catch Basin | ■ DOT Catch Basin |
| ● Drainage Manhole | — Storm Water Gravity Drain |
| ■ Stormwater BMP | — Swale |
| ★ Key Drainage Manhole | — Catchment |
| ✚ Interconnections | — Non-Urban Area |
| △ DOT Outfall | |

Stormwater Infrastructure Map Barnstable, MA

SHEET
G21



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| ▲ Outfalls | ○ DOT Manhole |
| ■ Catch Basin | ■ DOT Catch Basin |
| ● Drainage Manhole | — Storm Water Gravity Drain |
| ■ Stormwater BMP | — Swale |
| ★ Key Drainage Manhole | — Catchment |
| ✚ Interconnections | — Non-Urban Area |
| △ DOT Outfall | |

Stormwater Infrastructure Map Barnstable, MA

SHEET

G22

0 100 200 300 400 500
Feet



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SANDWICH

G4

H3

H4

OF-165

OF-166

OF-167

BLACKTHORN ROAD

TROTTERS LANE

REDBERRY LANE

SANTUIT-NEWTOWN ROAD

WHITE MOSS DRIVE

I2

I3

I4

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| ▲ Outfalls | ○ DOT Manhole |
| ■ Catch Basin | ■ DOT Catch Basin |
| ● Drainage Manhole | — Storm Water Gravity Drain |
| ■ Stormwater BMP | — Swale |
| ★ Key Drainage Manhole | — Catchment |
| ✚ Interconnections | — Non-Urban Area |
| △ DOT Outfall | |

**Stormwater Infrastructure
Map
Barnstable, MA**

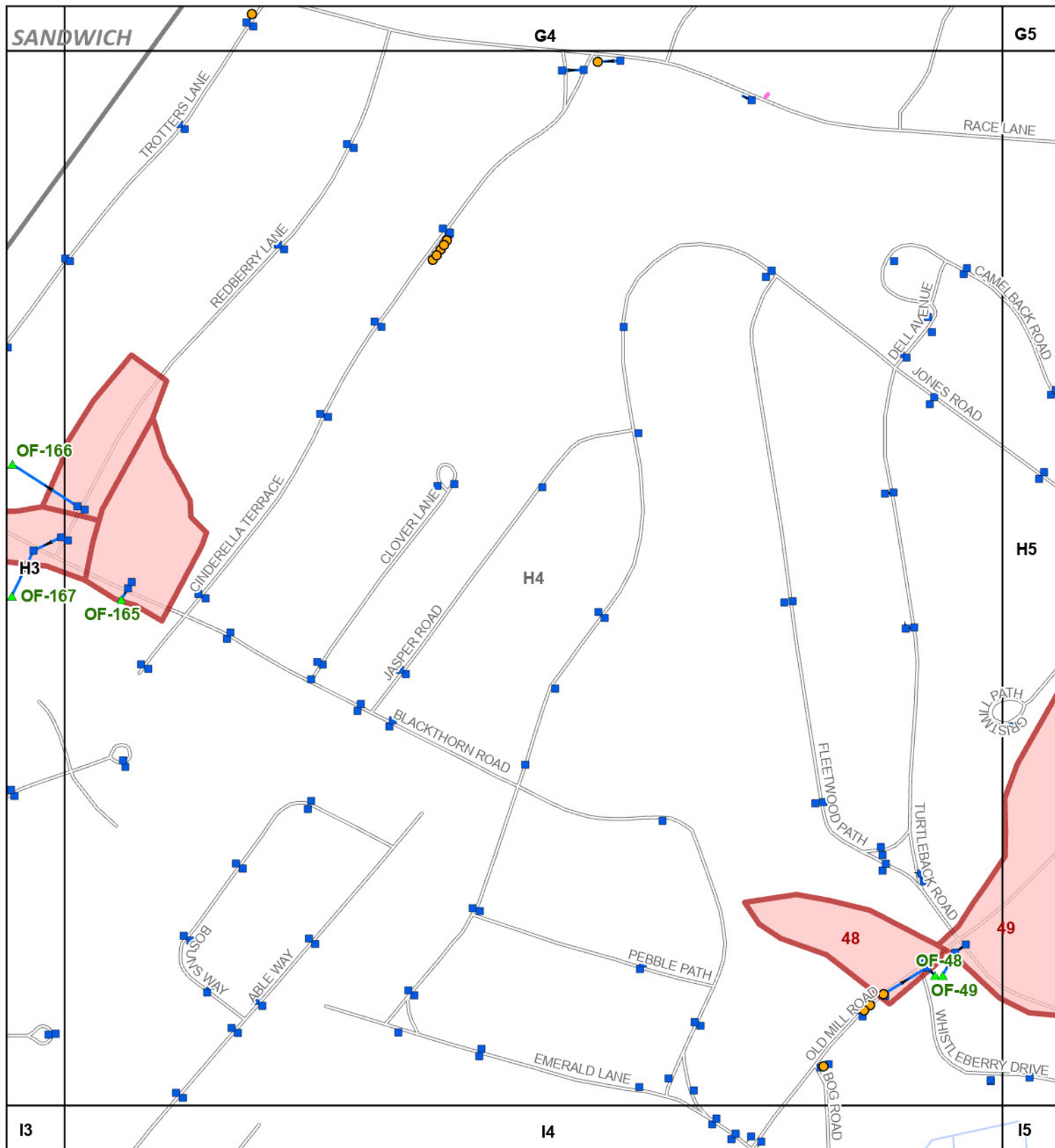
SHEET

H3

0 100 200 300 400 500
Feet



Comprehensive
Environmental
Incorporated



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| ▲ Outfalls | ○ DOT Manhole |
| ■ Catch Basin | ■ DOT Catch Basin |
| ● Drainage Manhole | — Storm Water Gravity Drain |
| ■ Stormwater BMP | — Swale |
| ★ Key Drainage Manhole | — Catchment |
| ✚ Interconnections | — Non-Urban Area |
| ▲ DOT Outfall | |

Stormwater Infrastructure Map Barnstable, MA

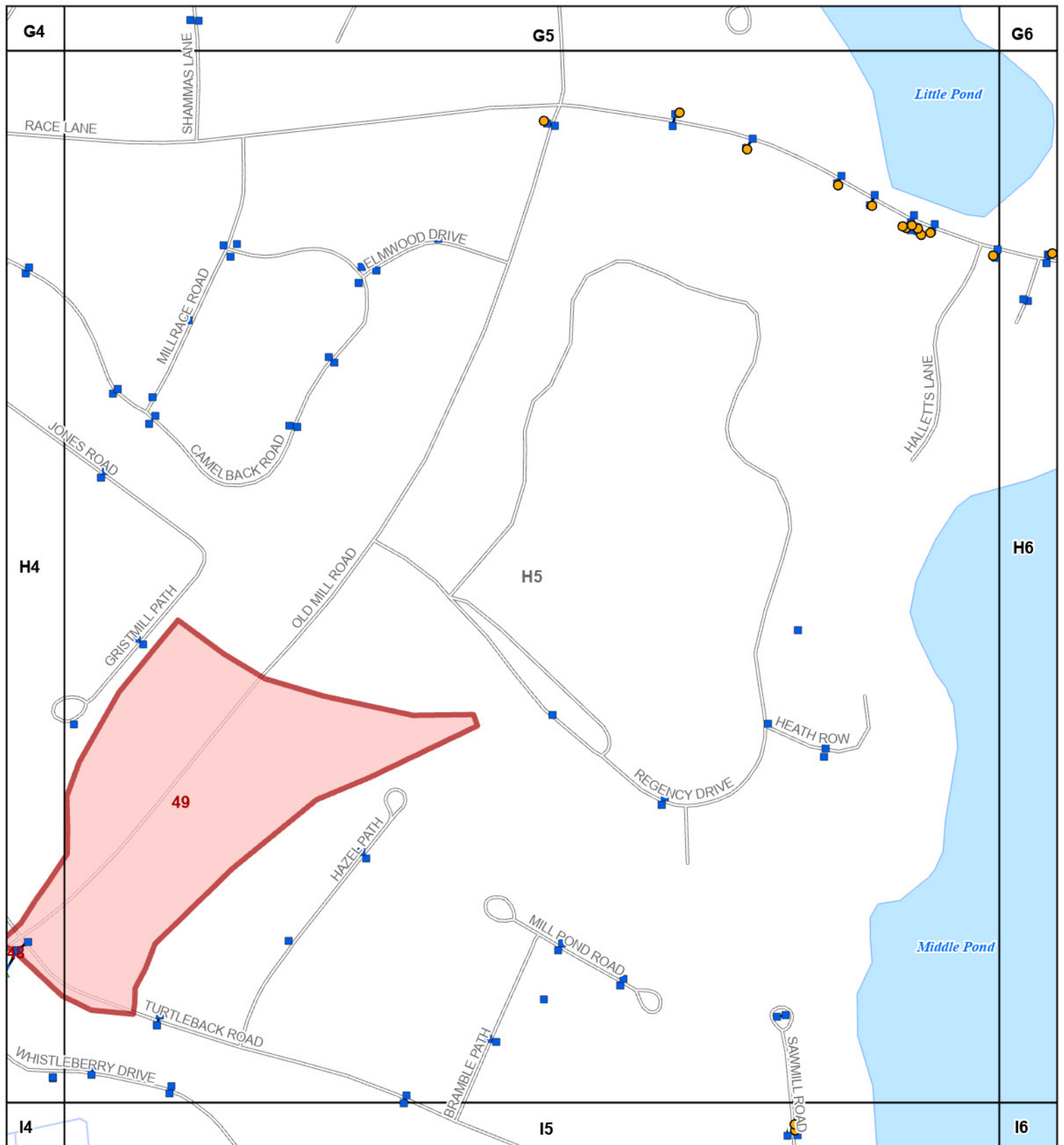
SHEET

H4

0 100 200 300 400 500
Feet



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Environmental
Incorporated



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| ▲ Outfalls | ○ DOT Manhole |
| ■ Catch Basin | ■ DOT Catch Basin |
| ● Drainage Manhole | — Storm Water Gravity Drain |
| ■ Stormwater BMP | — Swale |
| ★ Key Drainage Manhole | — Catchment |
| ✚ Interconnections | — Non-Urban Area |
| ▲ DOT Outfall | |

Stormwater Infrastructure Map Barnstable, MA

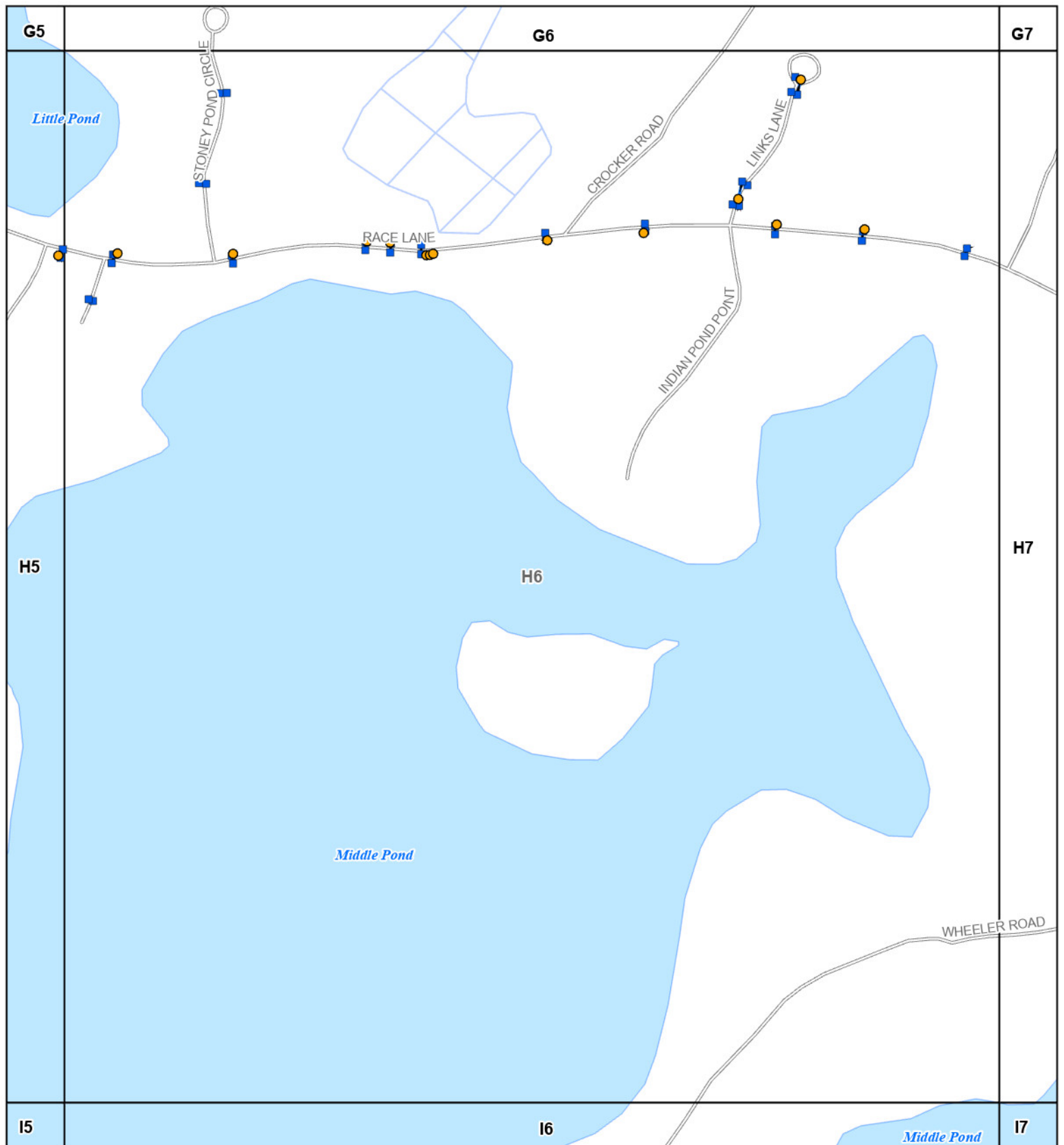
SHEET

H5

0 100 200 300 400 500
Feet



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| ▲ Outfalls | ● DOT Manhole |
| ■ Catch Basin | ■ DOT Catch Basin |
| ● Drainage Manhole | — Storm Water Gravity Drain |
| ■ Stormwater BMP | — Swale |
| ★ Key Drainage Manhole | — Catchment |
| ✚ Interconnections | — Non-Urban Area |
| ▲ DOT Outfall | |

Stormwater Infrastructure Map Barnstable, MA

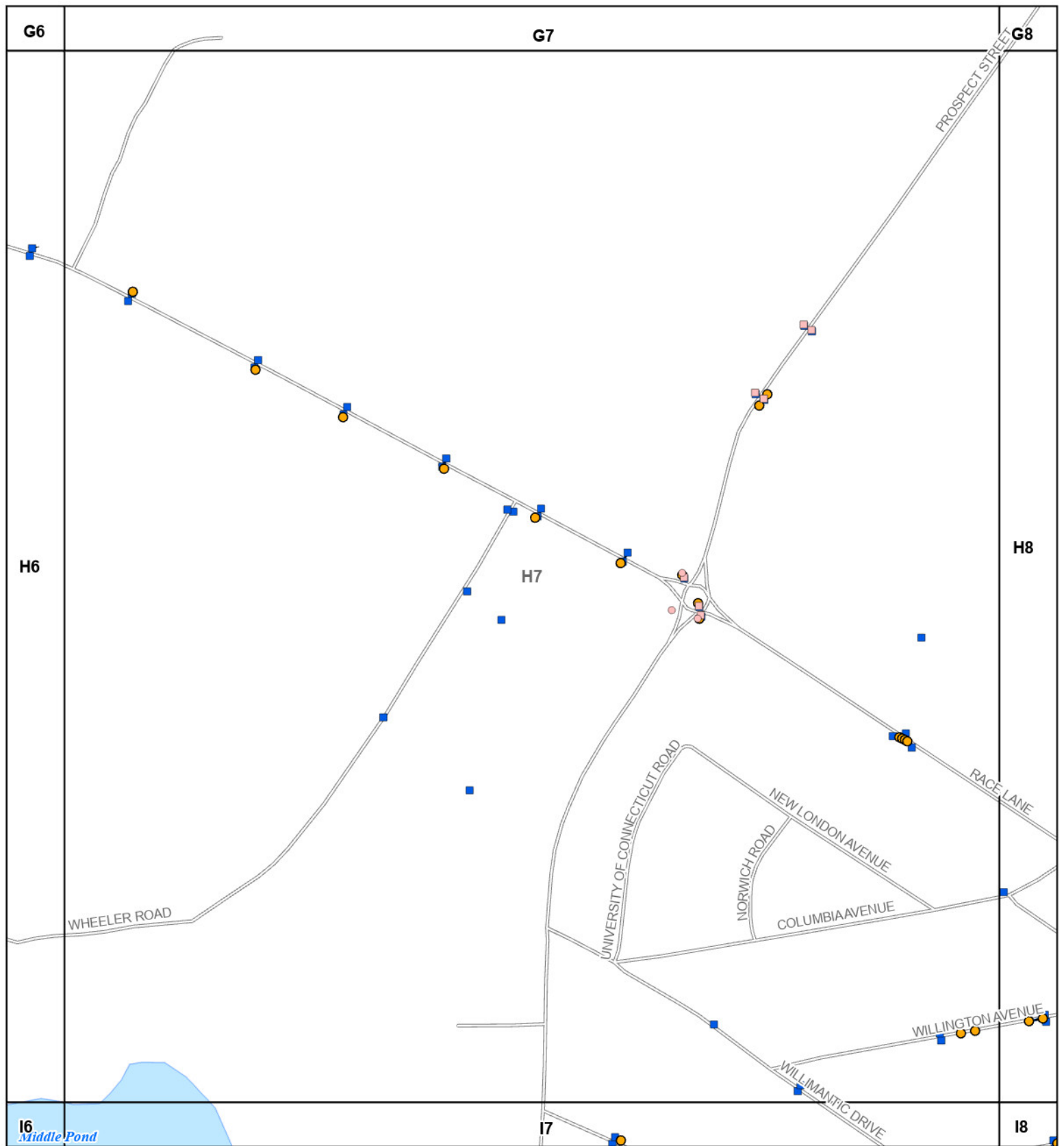
SHEET

H6

0 100 200 300 400 500
Feet



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Environmental
Incorporated



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| ■ Catch Basin | ■ DOT Catch Basin |
| ● Drainage Manhole | — Storm Water Gravity Drain |
| ■ Stormwater BMP | ~ Swale |
| ★ Key Drainage Manhole | — Catchment |
| ✚ Interconnections | — Non-Urban Area |
| ▲ DOT Outfall | |

Stormwater Infrastructure Map Barnstable, MA

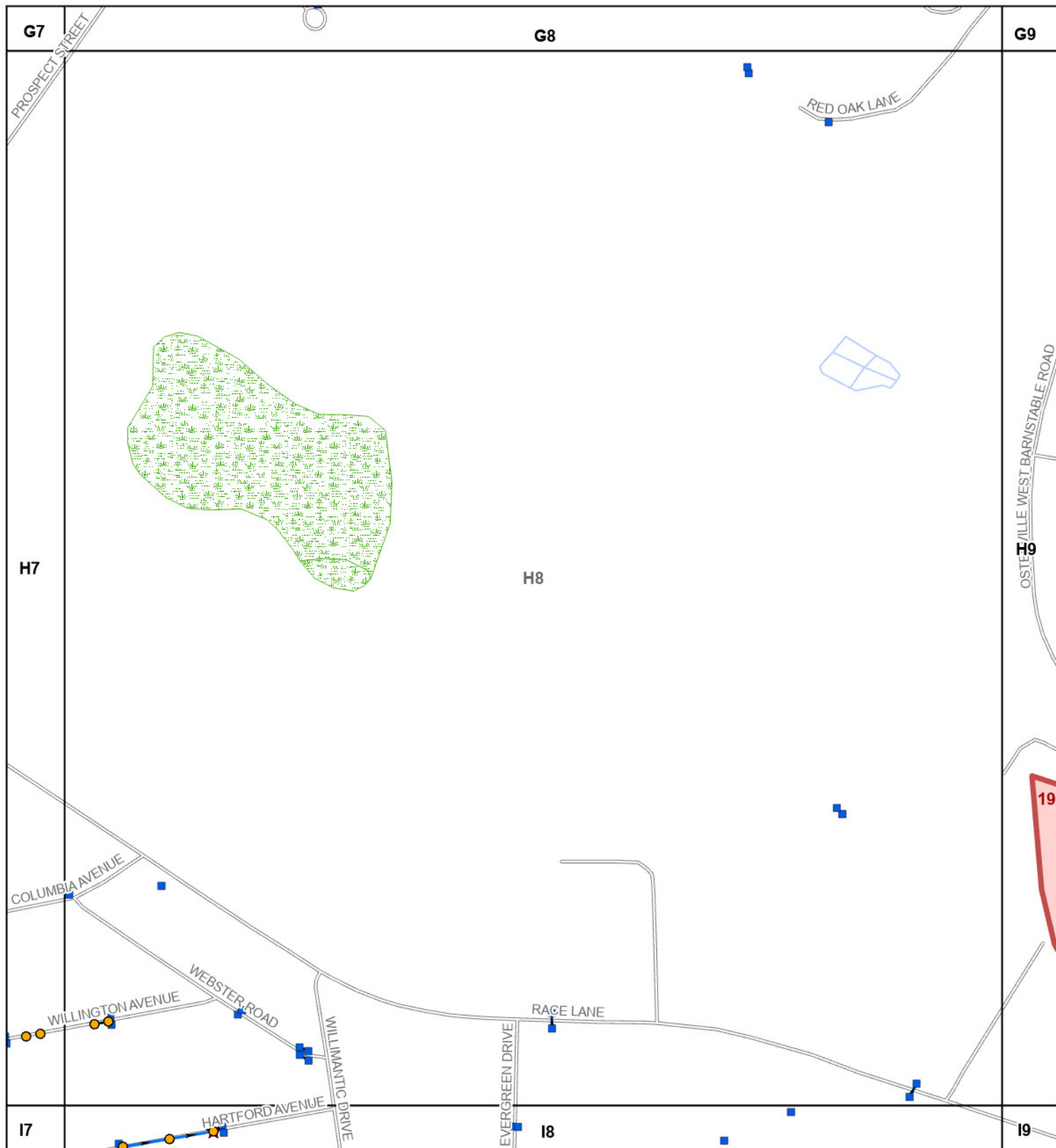
SHEET

H7

0 100 200 300 400 500
Feet



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Incorporated



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| ▲ Outfalls | ○ DOT Manhole |
| ■ Catch Basin | ■ DOT Catch Basin |
| ● Drainage Manhole | — Storm Water Gravity Drain |
| ■ Stormwater BMP | — Swale |
| ★ Key Drainage Manhole | — Catchment |
| ✚ Interconnections | — Non-Urban Area |
| △ DOT Outfall | |

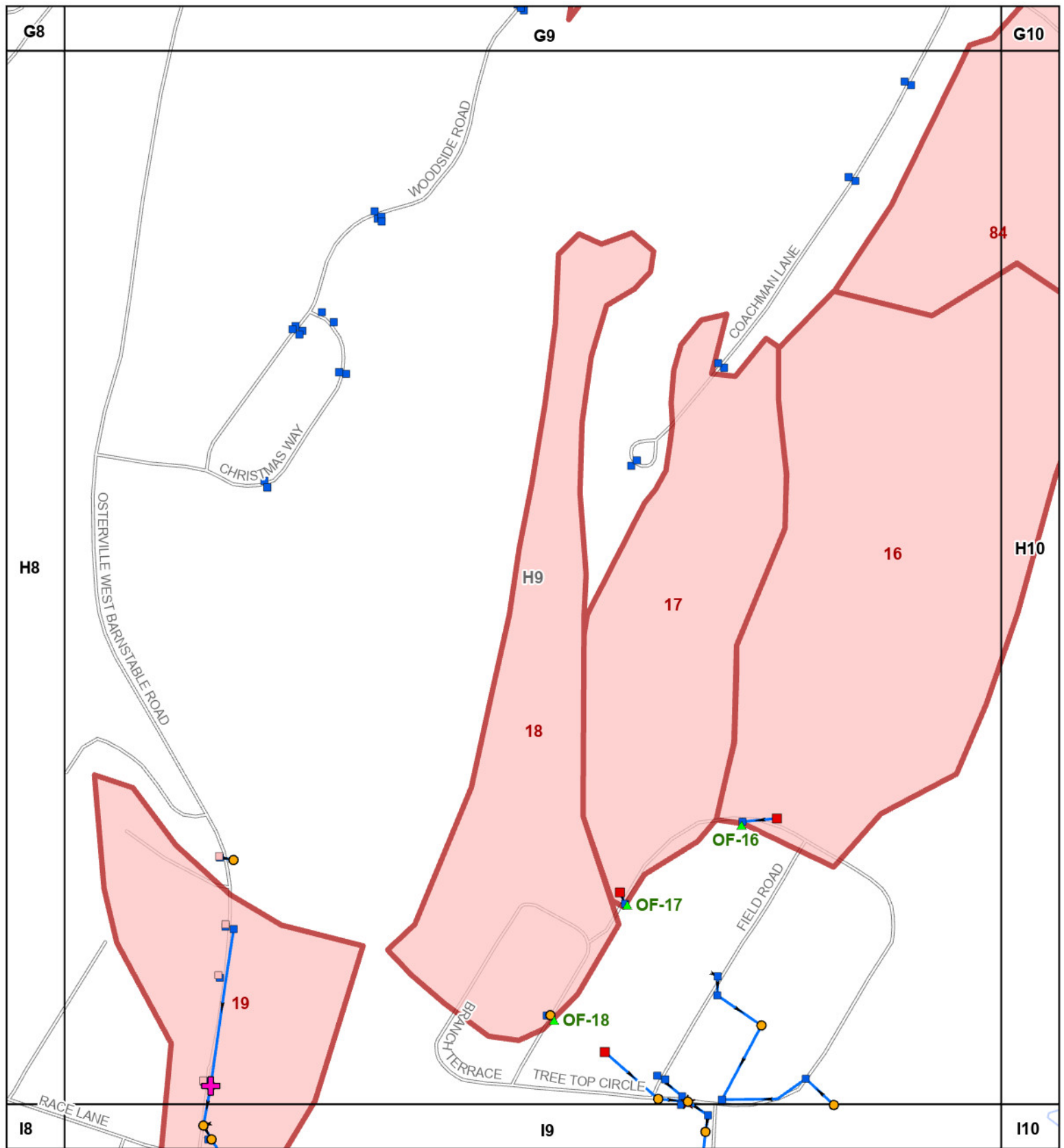
Stormwater Infrastructure Map Barnstable, MA

SHEET
H8

0 100 200 300 400 500
Feet



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| ▲ Outfalls | ○ DOT Manhole |
| ■ Catch Basin | ■ DOT Catch Basin |
| ● Drainage Manhole | — Storm Water Gravity Drain |
| ■ Stormwater BMP | — Swale |
| ★ Key Drainage Manhole | — Catchment |
| ✚ Interconnections | — Non-Urban Area |
| ▲ DOT Outfall | |

Stormwater Infrastructure Map Barnstable, MA

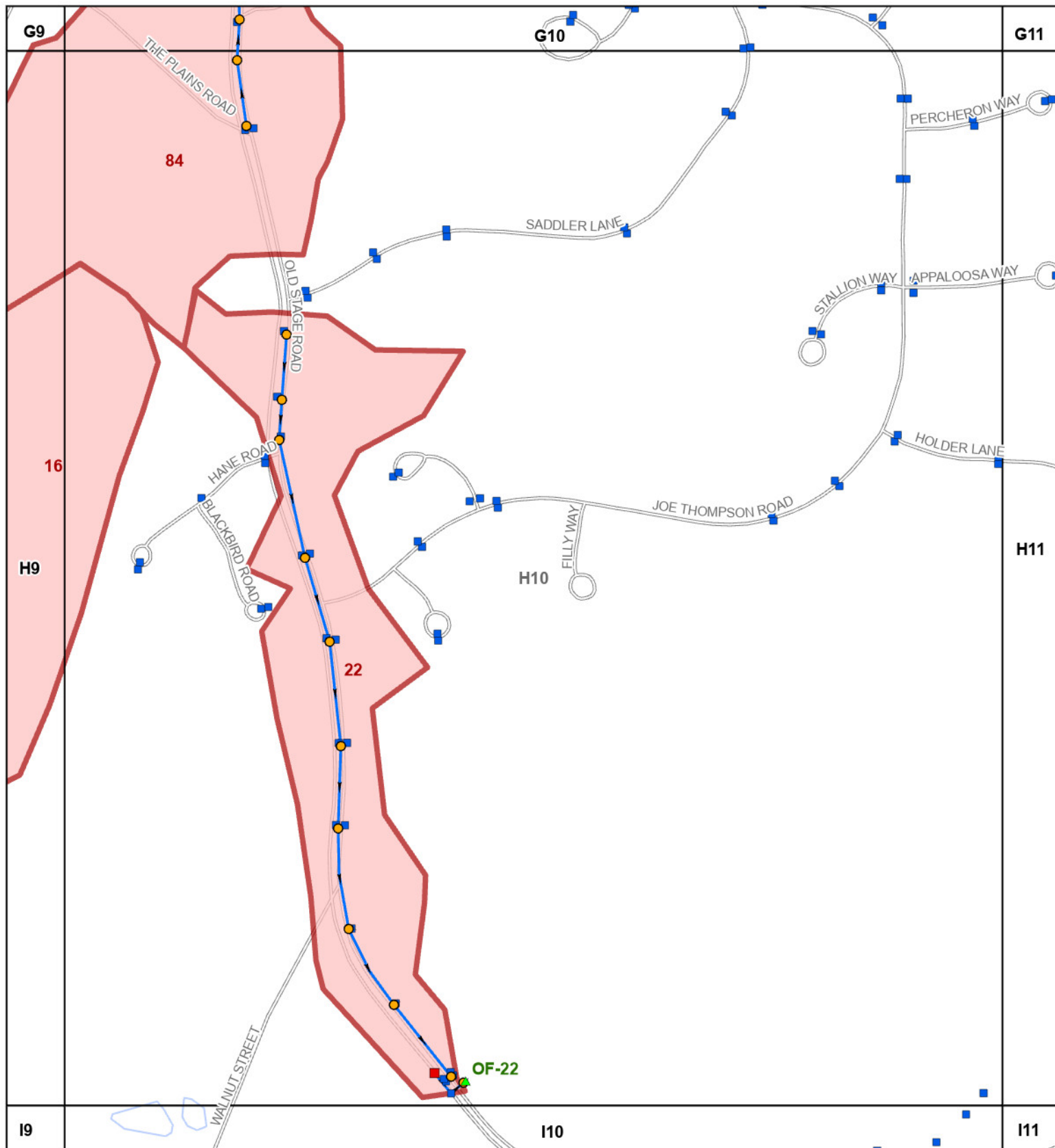
SHEET

H9

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Feet



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| ▲ Outfalls | ○ DOT Manhole |
| ■ Catch Basin | ■ DOT Catch Basin |
| ● Drainage Manhole | — Storm Water Gravity Drain |
| ■ Stormwater BMP | — Swale |
| ★ Key Drainage Manhole | — Catchment |
| ✚ Interconnections | — Non-Urban Area |
| △ DOT Outfall | |

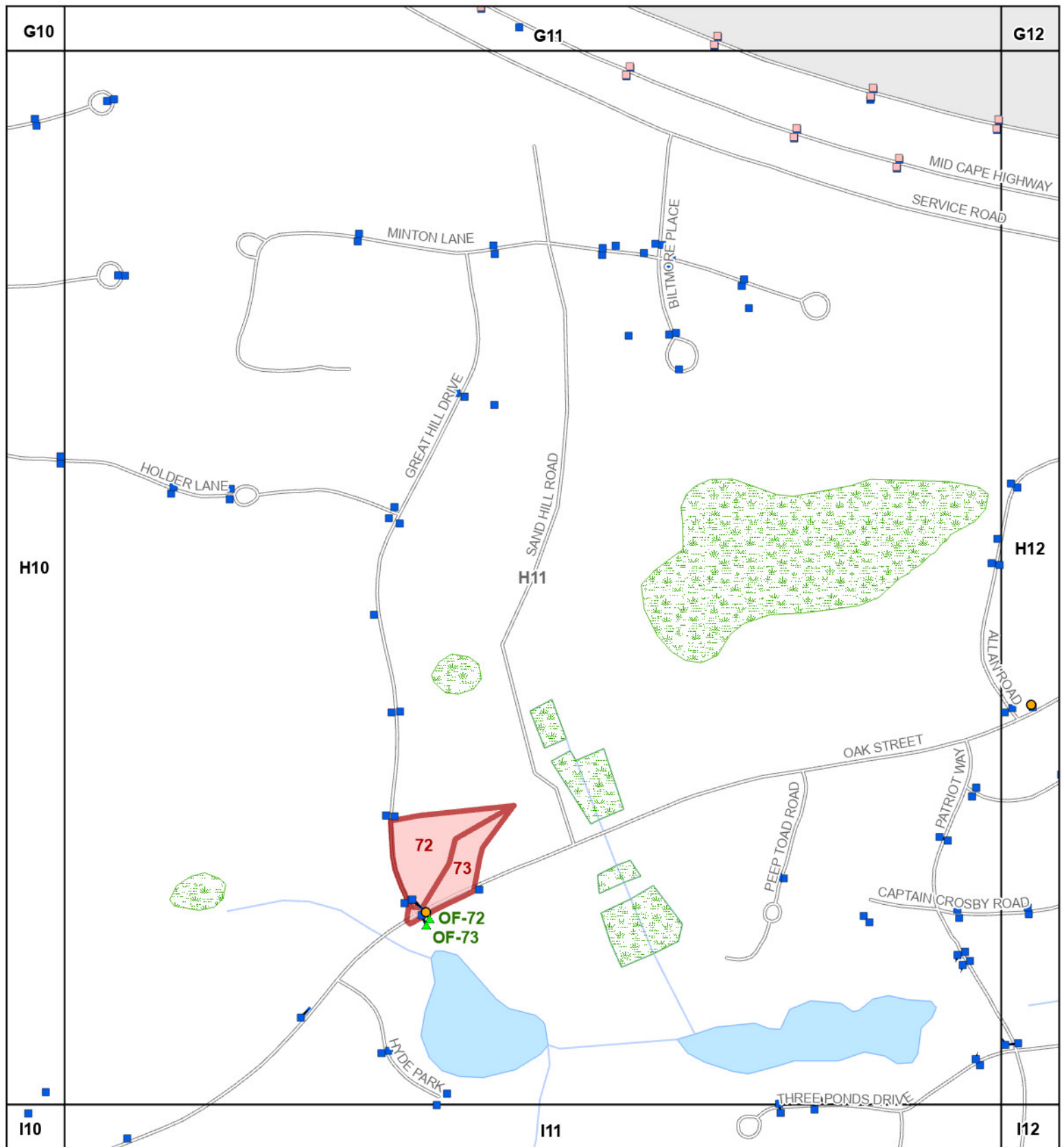
Stormwater Infrastructure Map Barnstable, MA

SHEET
H10

0 100 200 300 400 500
Feet



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| ▲ Outfalls | ○ DOT Manhole |
| ■ Catch Basin | ■ DOT Catch Basin |
| ● Drainage Manhole | — Storm Water Gravity Drain |
| ■ Stormwater BMP | — Swale |
| ★ Key Drainage Manhole | — Catchment |
| ✚ Interconnections | — Non-Urban Area |
| ▲ DOT Outfall | |

Stormwater Infrastructure Map Barnstable, MA

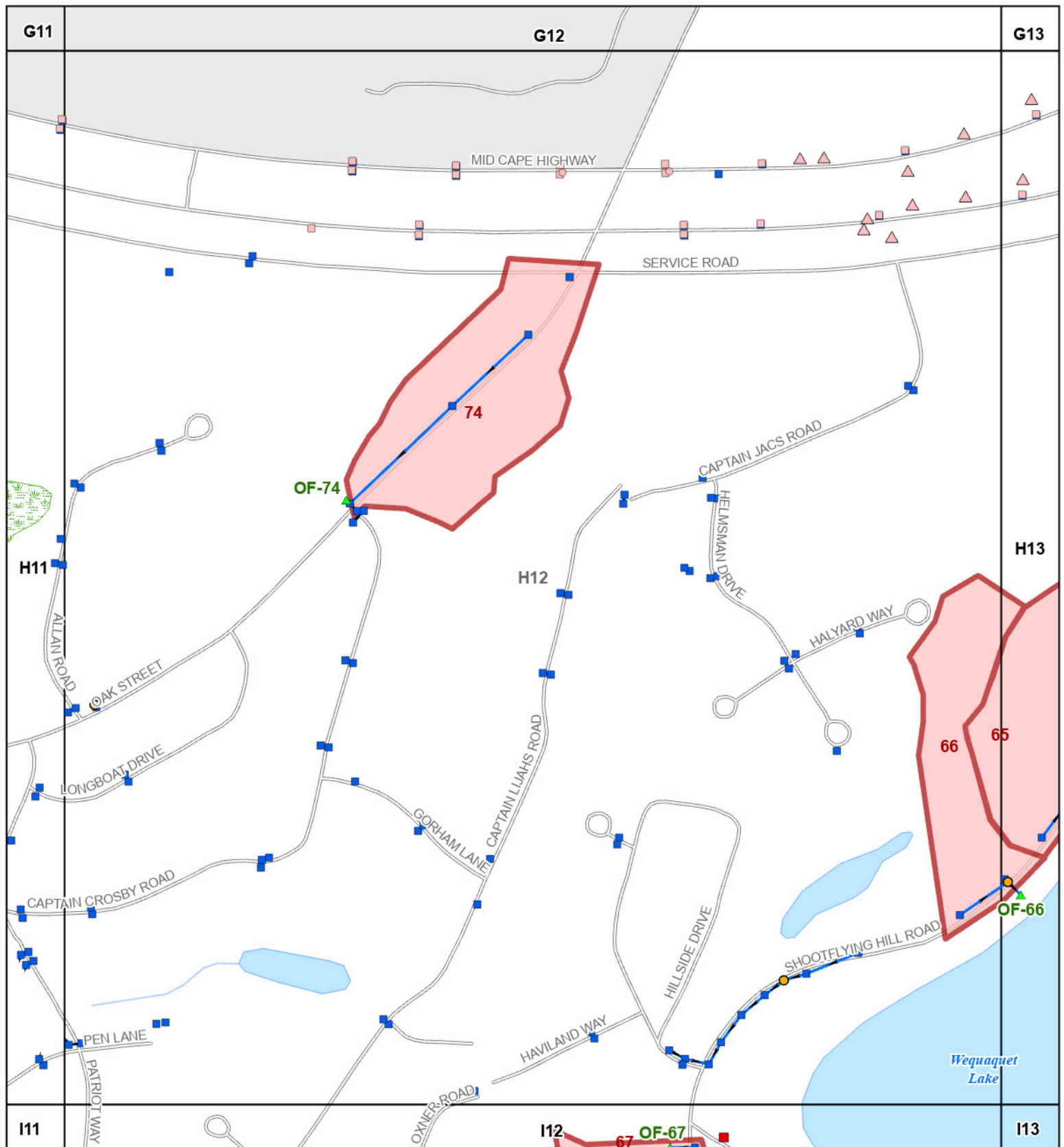
SHEET

H11

0 100 200 300 400 500
Feet



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Environmental
Incorporated



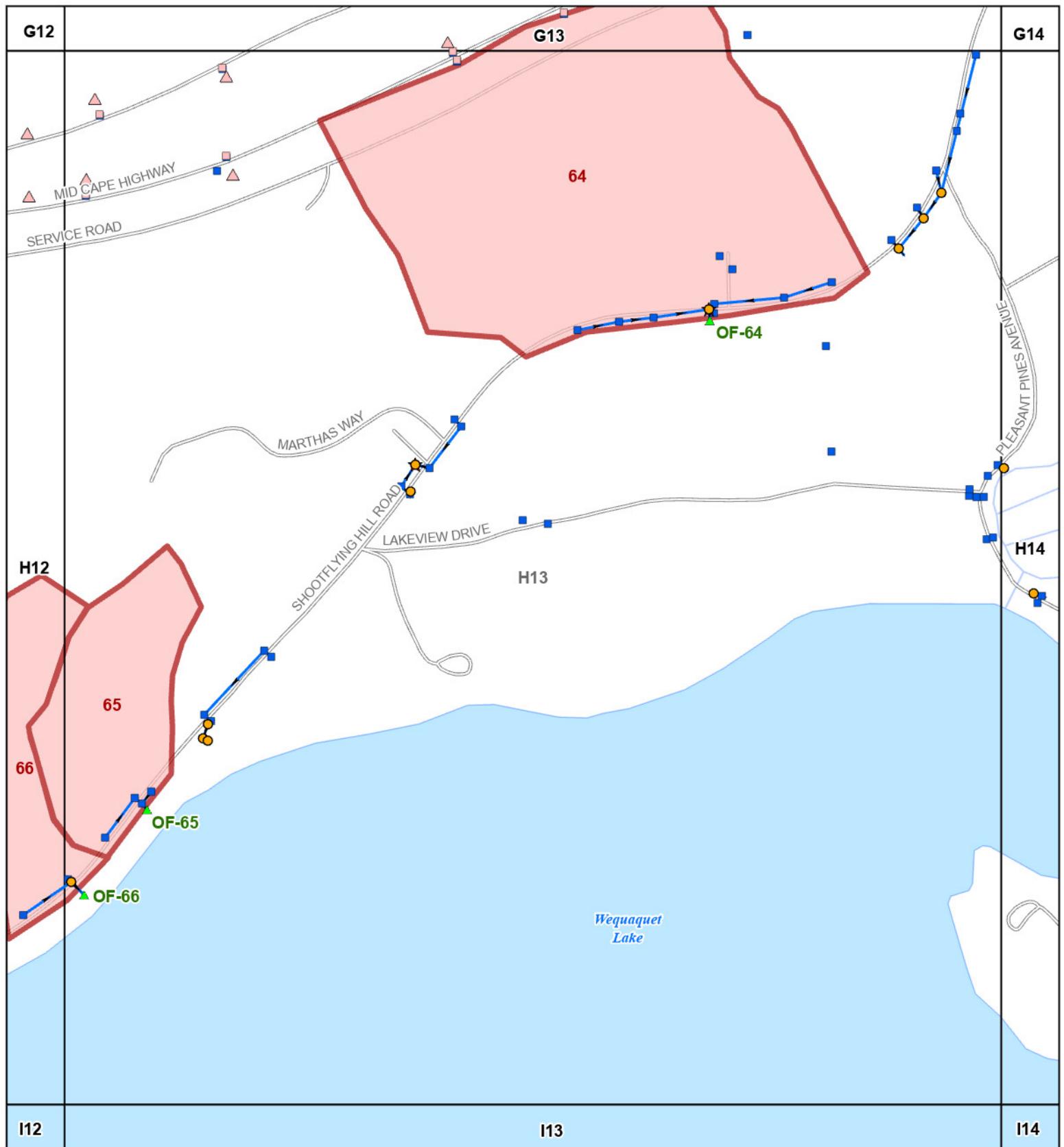
Stormwater Infrastructure Map Barnstable, MA

SHEET
H12

0 100 200 300 400 500
Feet



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| ▲ Outfalls | ○ DOT Manhole |
| ■ Catch Basin | □ DOT Catch Basin |
| ● Drainage Manhole | — Storm Water Gravity Drain |
| ■ Stormwater BMP | ~ Swale |
| ★ Key Drainage Manhole | ⬮ Catchment |
| ✚ Interconnections | ⬮ Non-Urban Area |
| △ DOT Outfall | |

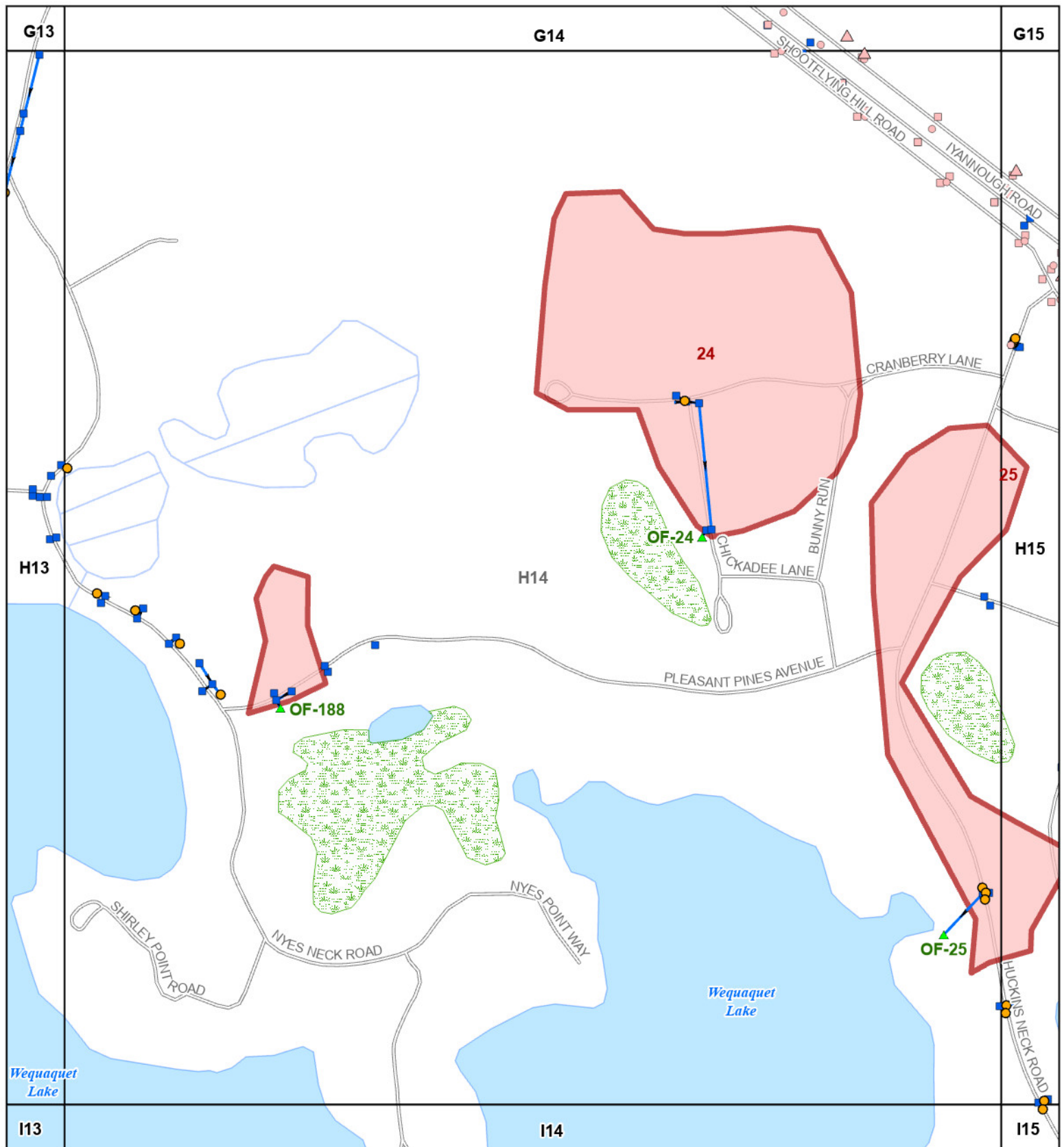
Stormwater Infrastructure Map Barnstable, MA

SHEET
H13

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Feet



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| ▲ Outfalls | ● DOT Manhole |
| ■ Catch Basin | ■ DOT Catch Basin |
| ● Drainage Manhole | — Storm Water Gravity Drain |
| ■ Stormwater BMP | — Swale |
| ★ Key Drainage Manhole | — Catchment |
| ✚ Interconnections | — Non-Urban Area |
| ▲ DOT Outfall | |

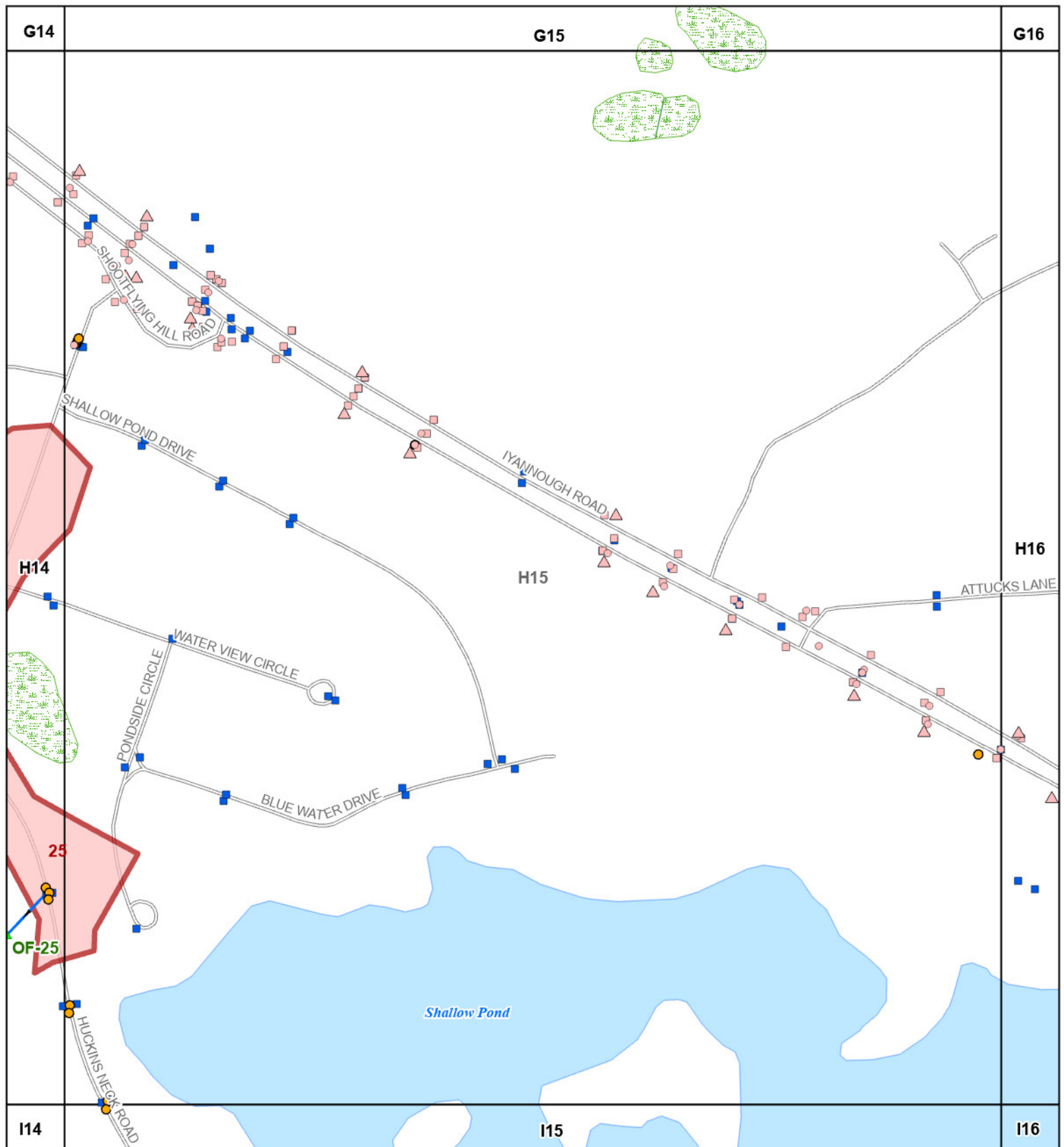
Stormwater Infrastructure Map Barnstable, MA

SHEET
H14

0 100 200 300 400 500
Feet



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| ▲ Outfalls | ● DOT Manhole |
| ■ Catch Basin | ■ DOT Catch Basin |
| ● Drainage Manhole | — Storm Water Gravity Drain |
| ■ Stormwater BMP | — Swale |
| ★ Key Drainage Manhole | — Catchment |
| ✚ Interconnections | — Non-Urban Area |
| ▲ DOT Outfall | |

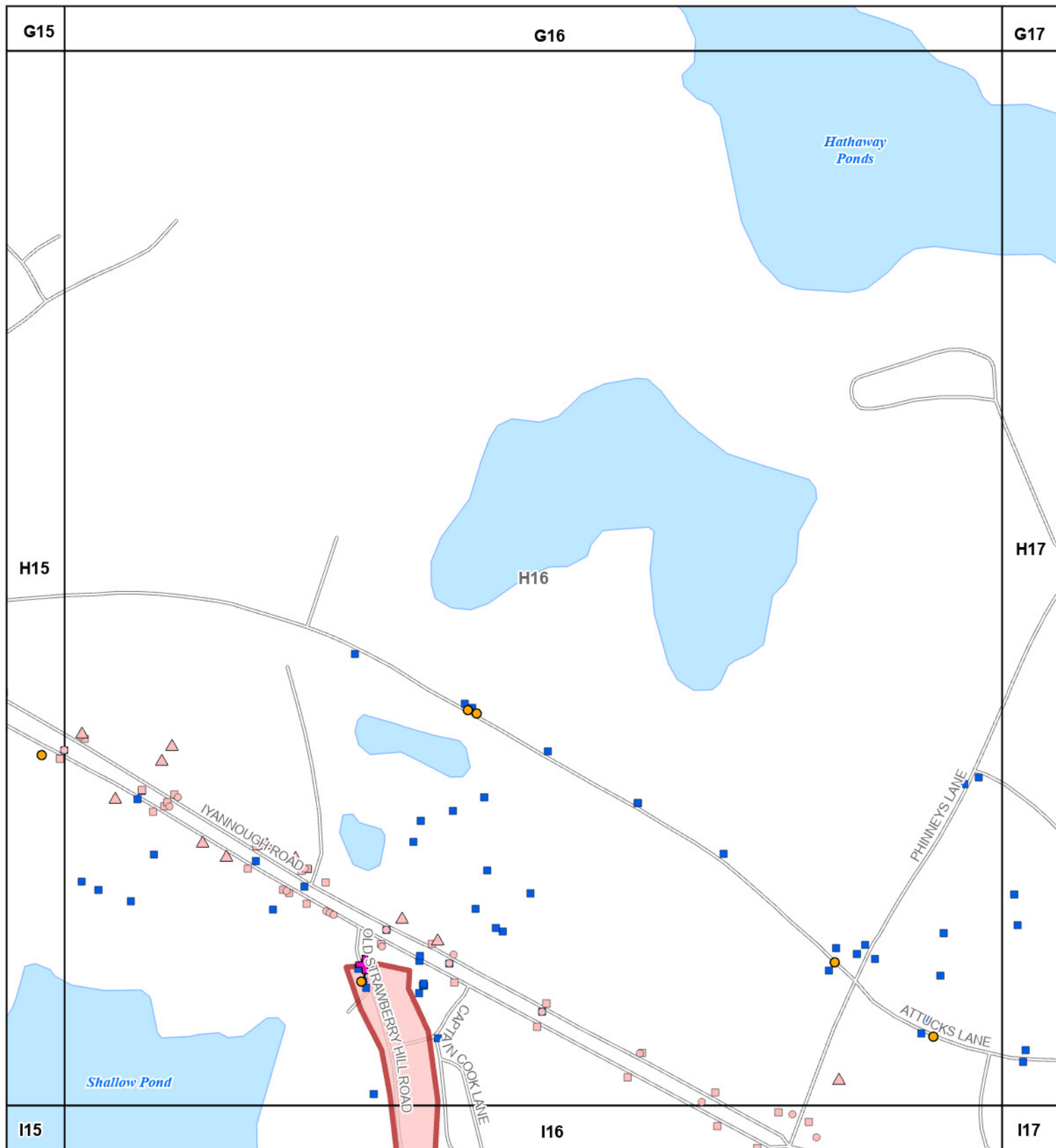
Stormwater Infrastructure Map Barnstable, MA

SHEET
H15

0 100 200 300 400 500
Feet



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Environmental
Incorporated



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| ▲ Outfalls | ● DOT Manhole |
| ■ Catch Basin | ■ DOT Catch Basin |
| ● Drainage Manhole | — Storm Water Gravity Drain |
| ■ Stormwater BMP | — Swale |
| ★ Key Drainage Manhole | — Catchment |
| ✚ Interconnections | — Non-Urban Area |
| ▲ DOT Outfall | |

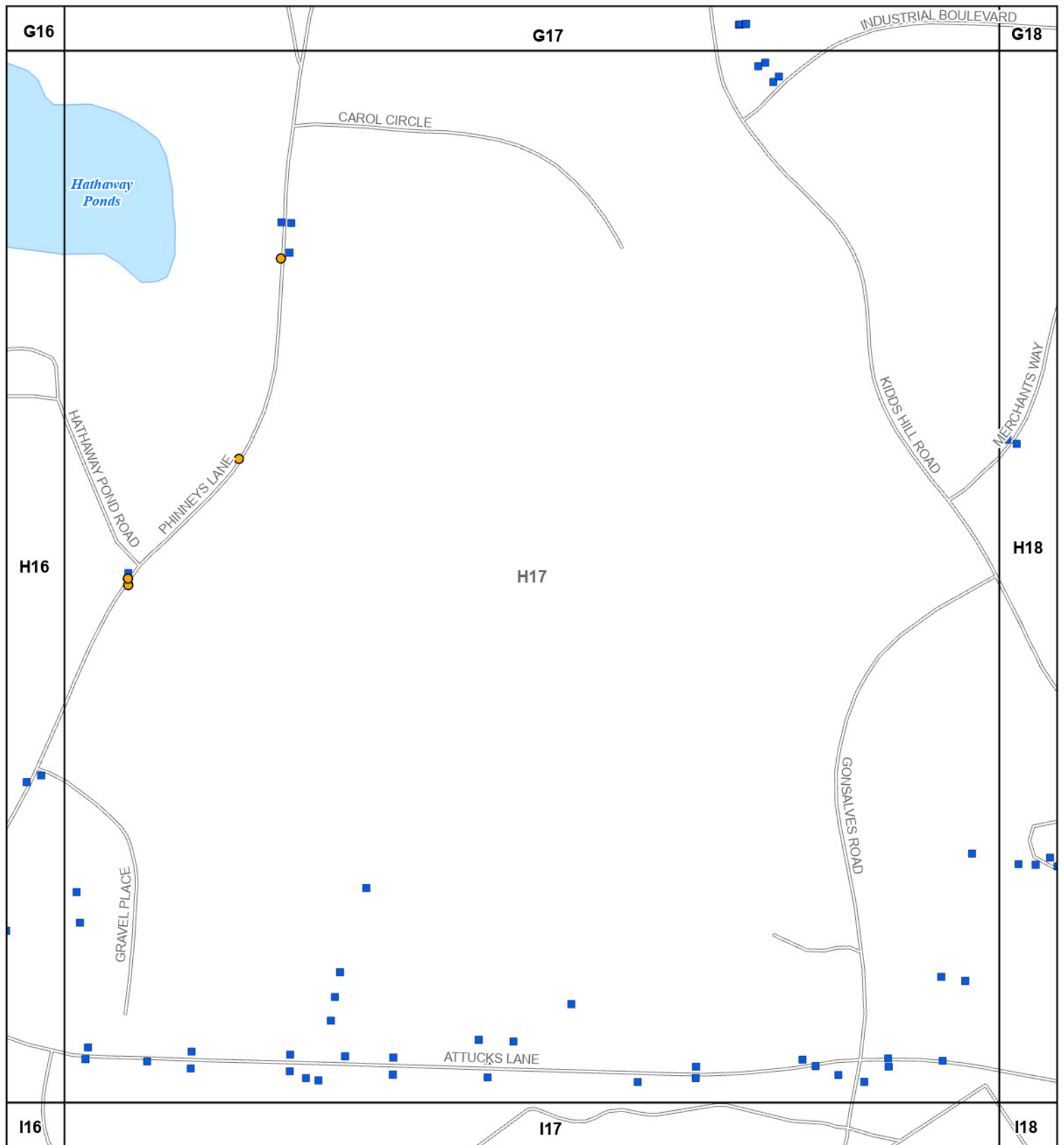
Stormwater Infrastructure Map Barnstable, MA

SHEET
H16

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Feet



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Environmental
Incorporated



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| ▲ Outfalls | ○ DOT Manhole |
| ■ Catch Basin | ■ DOT Catch Basin |
| ● Drainage Manhole | — Storm Water Gravity Drain |
| ■ Stormwater BMP | ~ Swale |
| ★ Key Drainage Manhole | ⬮ Catchment |
| ✚ Interconnections | ☁ Non-Urban Area |
| ▲ DOT Outfall | |

Stormwater Infrastructure Map Barnstable, MA

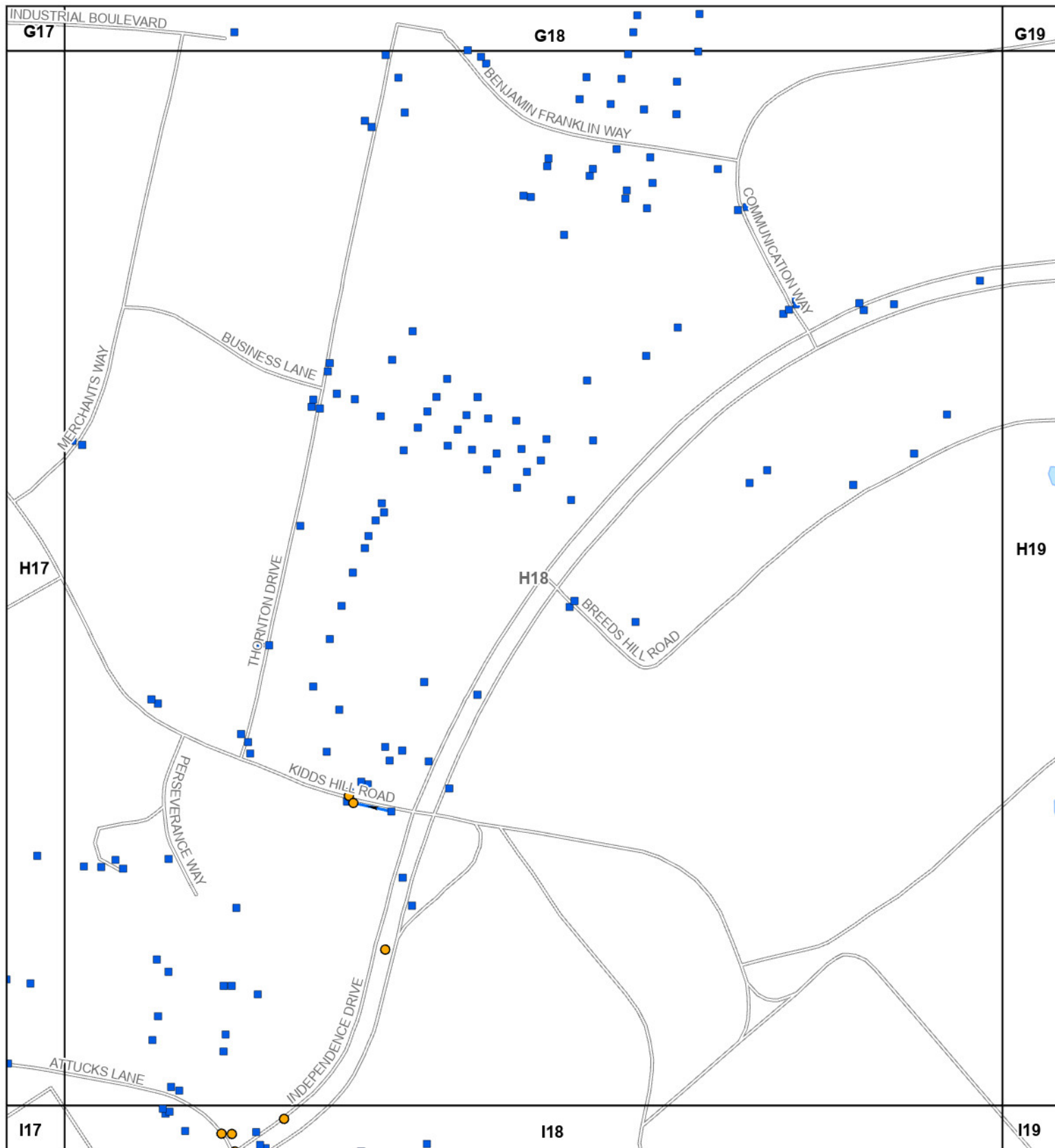
SHEET

H17

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Environmental
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| ▲ Outfalls | ○ DOT Manhole |
| ■ Catch Basin | ■ DOT Catch Basin |
| ● Drainage Manhole | — Storm Water Gravity Drain |
| ■ Stormwater BMP | — Swale |
| ★ Key Drainage Manhole | — Catchment |
| ✚ Interconnections | — Non-Urban Area |
| △ DOT Outfall | |

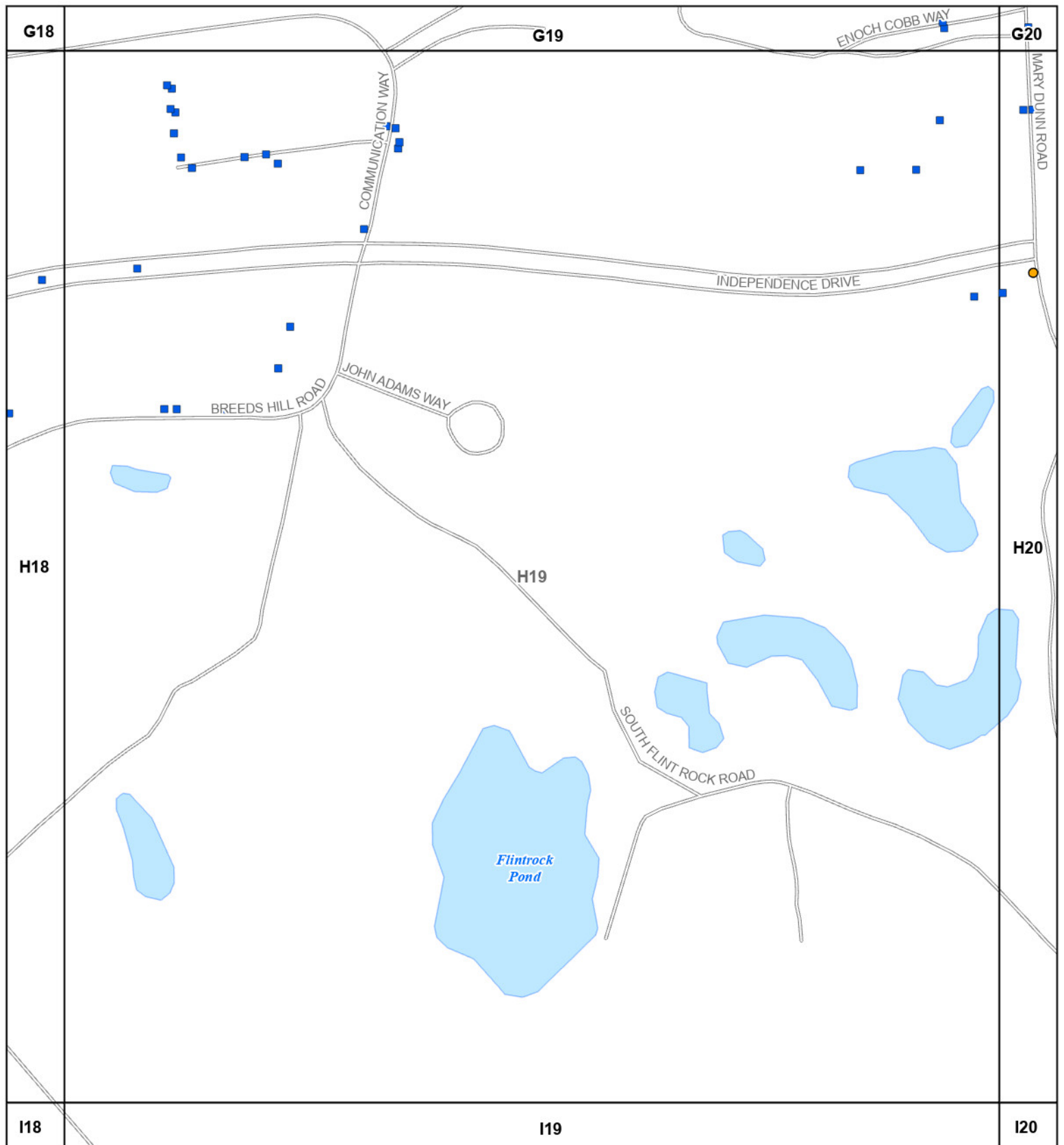
Stormwater Infrastructure Map Barnstable, MA

SHEET
H18

0 100 200 300 400 500
Feet

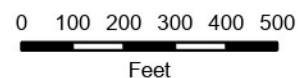


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Stormwater Infrastructure Map Barnstable, MA

**SHEET
H19**



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Environmental
Incorporated**



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| ▲ Outfalls | ● DOT Manhole |
| ■ Catch Basin | ■ DOT Catch Basin |
| ● Drainage Manhole | — Storm Water Gravity Drain |
| ■ Stormwater BMP | ~ Swale |
| ★ Key Drainage Manhole | — Catchment |
| ✚ Interconnections | — Non-Urban Area |
| ▲ DOT Outfall | |

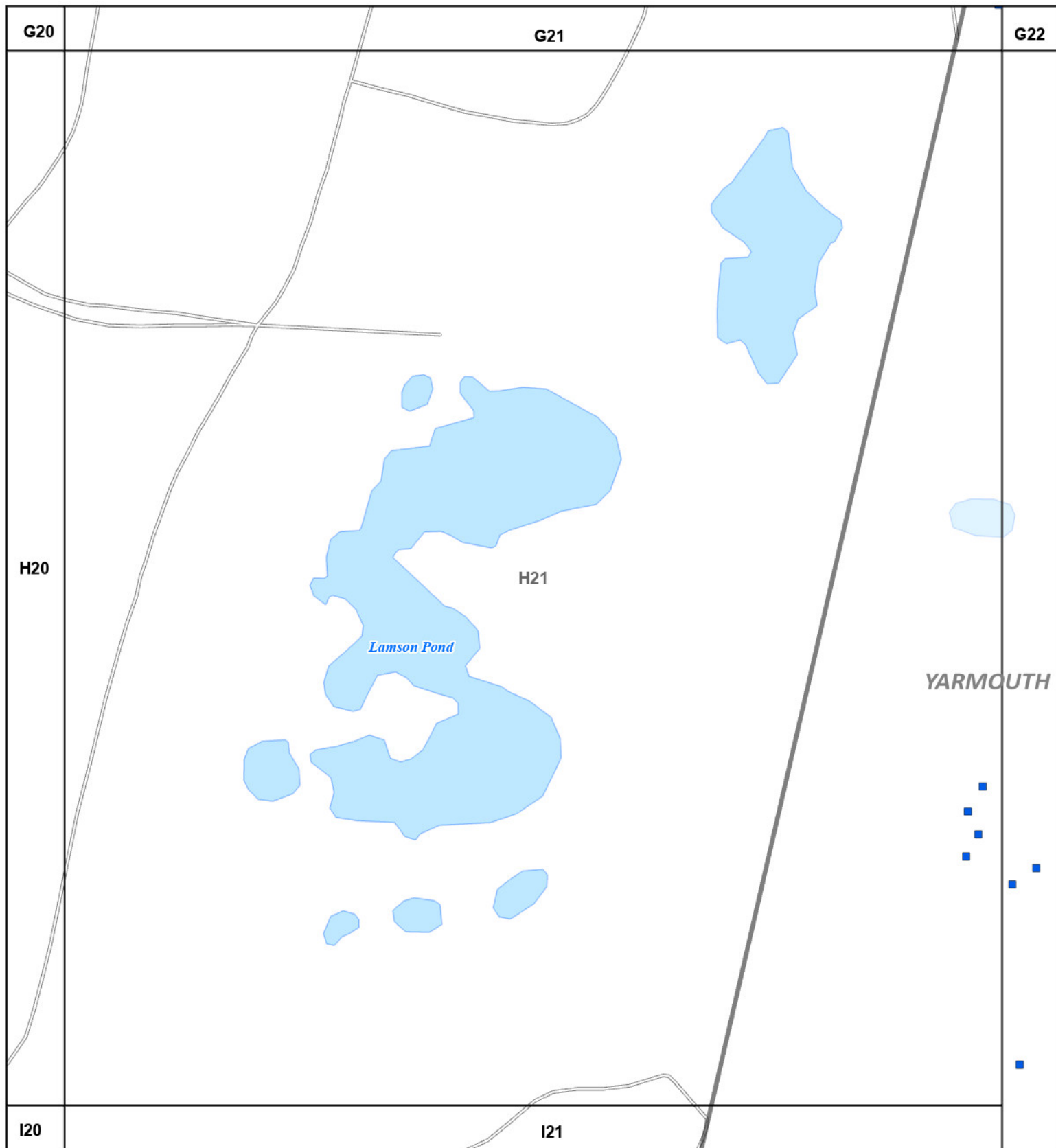
Stormwater Infrastructure Map Barnstable, MA

SHEET
H20

0 100 200 300 400 500
Feet



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| ▲ Outfalls | ● DOT Manhole |
| ■ Catch Basin | ■ DOT Catch Basin |
| ● Drainage Manhole | — Storm Water Gravity Drain |
| ■ Stormwater BMP | — Swale |
| ★ Key Drainage Manhole | — Catchment |
| ✚ Interconnections | — Non-Urban Area |
| ▲ DOT Outfall | |

Stormwater Infrastructure Map Barnstable, MA

SHEET
H21

0 100 200 300 400 500
Feet



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Environmental
Incorporated

I2

J3

J1

J2

J3

- | | |
|------------------------|-----------------------------|
| ▲ Outfalls | ○ DOT Manhole |
| ■ Catch Basin | ■ DOT Catch Basin |
| ● Drainage Manhole | — Storm Water Gravity Drain |
| ■ Stormwater BMP | — Swale |
| ★ Key Drainage Manhole | — Catchment |
| ✚ Interconnections | — Non-Urban Area |
| △ DOT Outfall | |

Stormwater Infrastructure Map Barnstable, MA

SHEET

I2

0 100 200 300 400 500
Feet



Comprehensive
Environmental
Incorporated

SANDWICH

H3

H4

I2

I3

I4

J2

J3

J4

Long Pond

Stormwater Infrastructure Map Barnstable, MA

SHEET

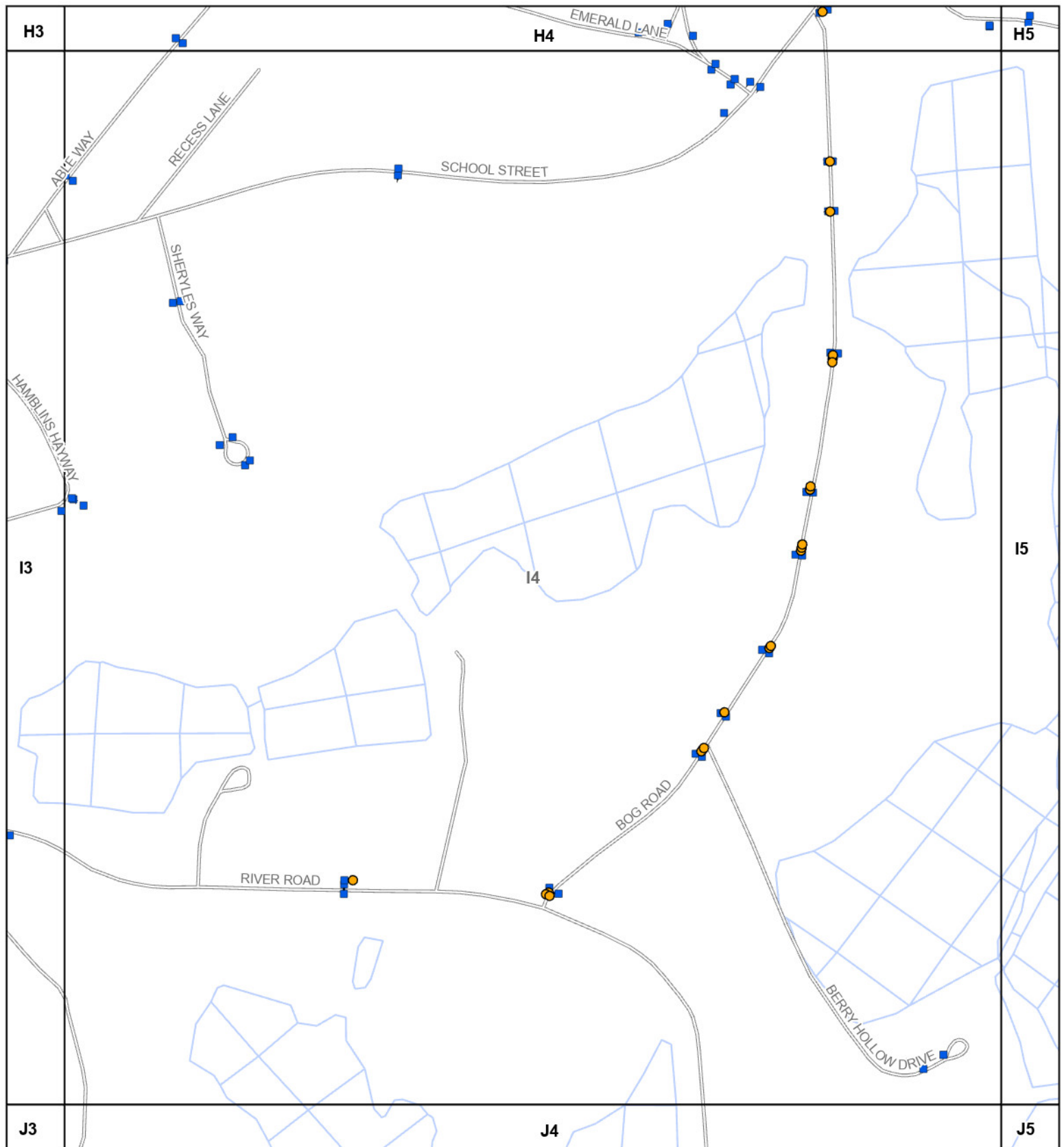
I3

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|------------------------|-----------------------------|
| ▲ Outfalls | ○ DOT Manhole |
| ■ Catch Basin | ■ DOT Catch Basin |
| ● Drainage Manhole | — Storm Water Gravity Drain |
| ■ Stormwater BMP | — Swale |
| ★ Key Drainage Manhole | — Catchment |
| ✚ Interconnections | — Non-Urban Area |
| △ DOT Outfall | |

0 100 200 300 400 500
Feet



Comprehensive
Environmental
Incorporated



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| ▲ Outfalls | ○ DOT Manhole |
| ■ Catch Basin | ■ DOT Catch Basin |
| ● Drainage Manhole | — Storm Water Gravity Drain |
| ■ Stormwater BMP | — Swale |
| ★ Key Drainage Manhole | — Catchment |
| ✚ Interconnections | — Non-Urban Area |
| △ DOT Outfall | |

Stormwater Infrastructure Map Barnstable, MA

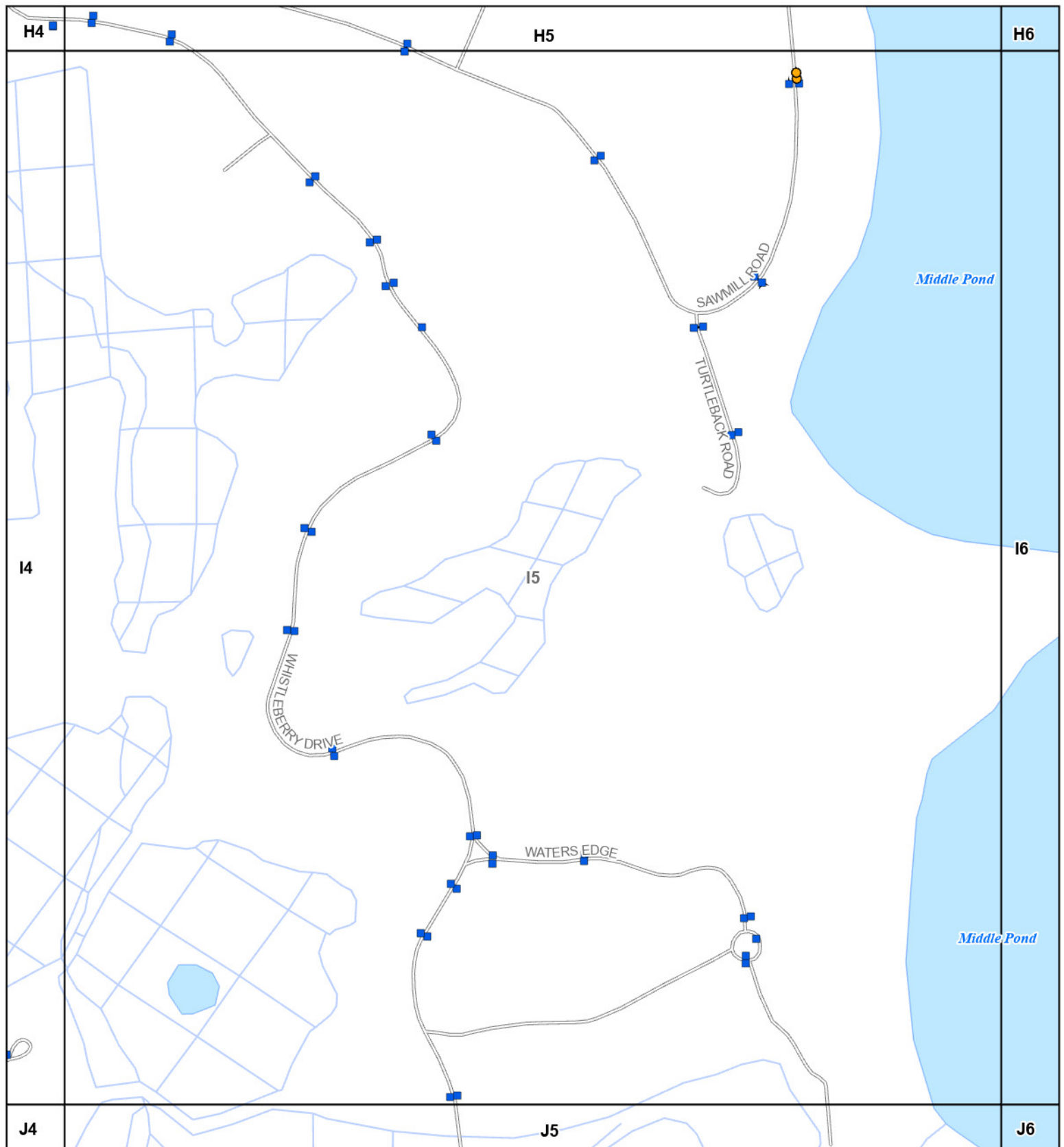
SHEET

I4

0 100 200 300 400 500
Feet



Comprehensive
Environmental
Incorporated



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| ▲ Outfalls | ○ DOT Manhole |
| ■ Catch Basin | ■ DOT Catch Basin |
| ● Drainage Manhole | — Storm Water Gravity Drain |
| ■ Stormwater BMP | — Swale |
| ★ Key Drainage Manhole | — Catchment |
| ✚ Interconnections | — Non-Urban Area |
| ▲ DOT Outfall | |

Stormwater Infrastructure Map Barnstable, MA

SHEET

I5

0 100 200 300 400 500
Feet



Comprehensive
Environmental
Incorporated



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| ▲ Outfalls | ● DOT Manhole |
| ■ Catch Basin | ■ DOT Catch Basin |
| ● Drainage Manhole | — Storm Water Gravity Drain |
| ■ Stormwater BMP | — Swale |
| ★ Key Drainage Manhole | — Catchment |
| ✚ Interconnections | — Non-Urban Area |
| ▲ DOT Outfall | |

Stormwater Infrastructure Map Barnstable, MA

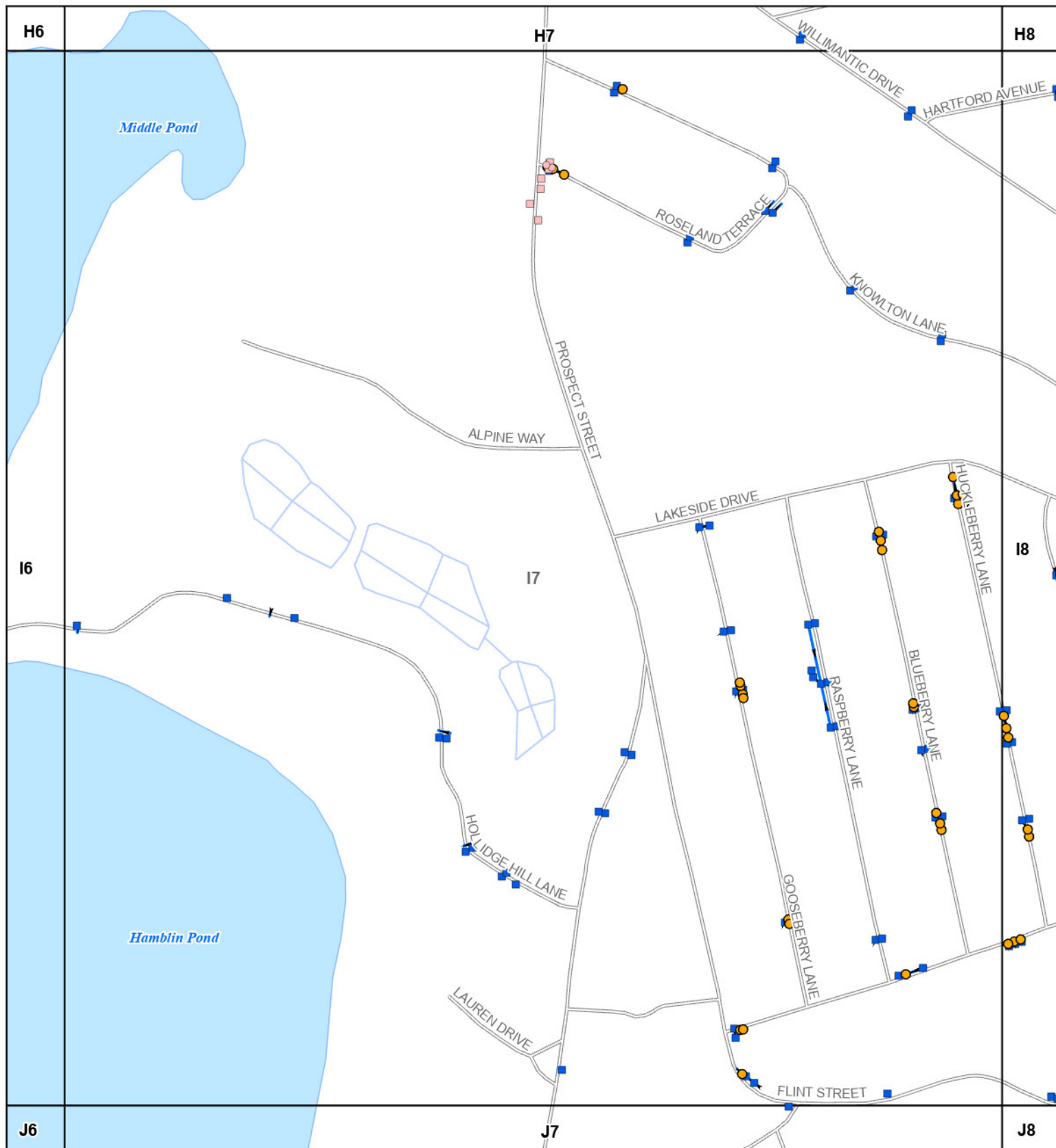
SHEET

I6

0 100 200 300 400 500
Feet



Comprehensive
Environmental
Incorporated



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| ● Drainage Manhole | — Storm Water Gravity Drain |
| ■ Stormwater BMP | ~ Swale |
| ★ Key Drainage Manhole | ○ Catchment |
| ✚ Interconnections | ☁ Non-Urban Area |
| ▲ DOT Outfall | |

Stormwater Infrastructure Map Barnstable, MA

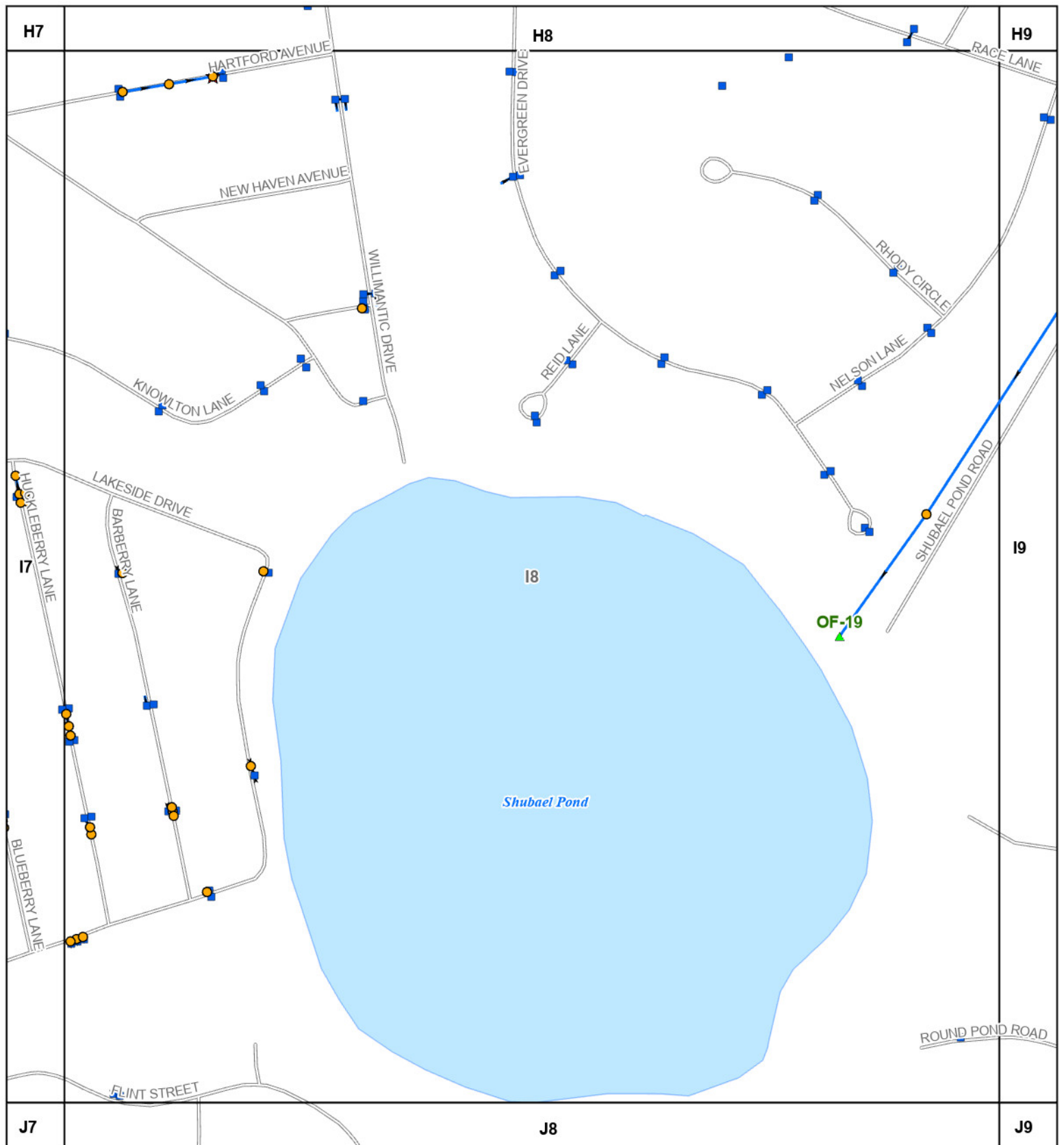
SHEET

17

0 100 200 300 400 500
Feet



Comprehensive
Environmental
Incorporated



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| ▲ Outfalls | ● DOT Manhole |
| ■ Catch Basin | ■ DOT Catch Basin |
| ● Drainage Manhole | — Storm Water Gravity Drain |
| ■ Stormwater BMP | — Swale |
| ★ Key Drainage Manhole | — Catchment |
| ✚ Interconnections | — Non-Urban Area |
| ▲ DOT Outfall | |

Stormwater Infrastructure Map Barnstable, MA

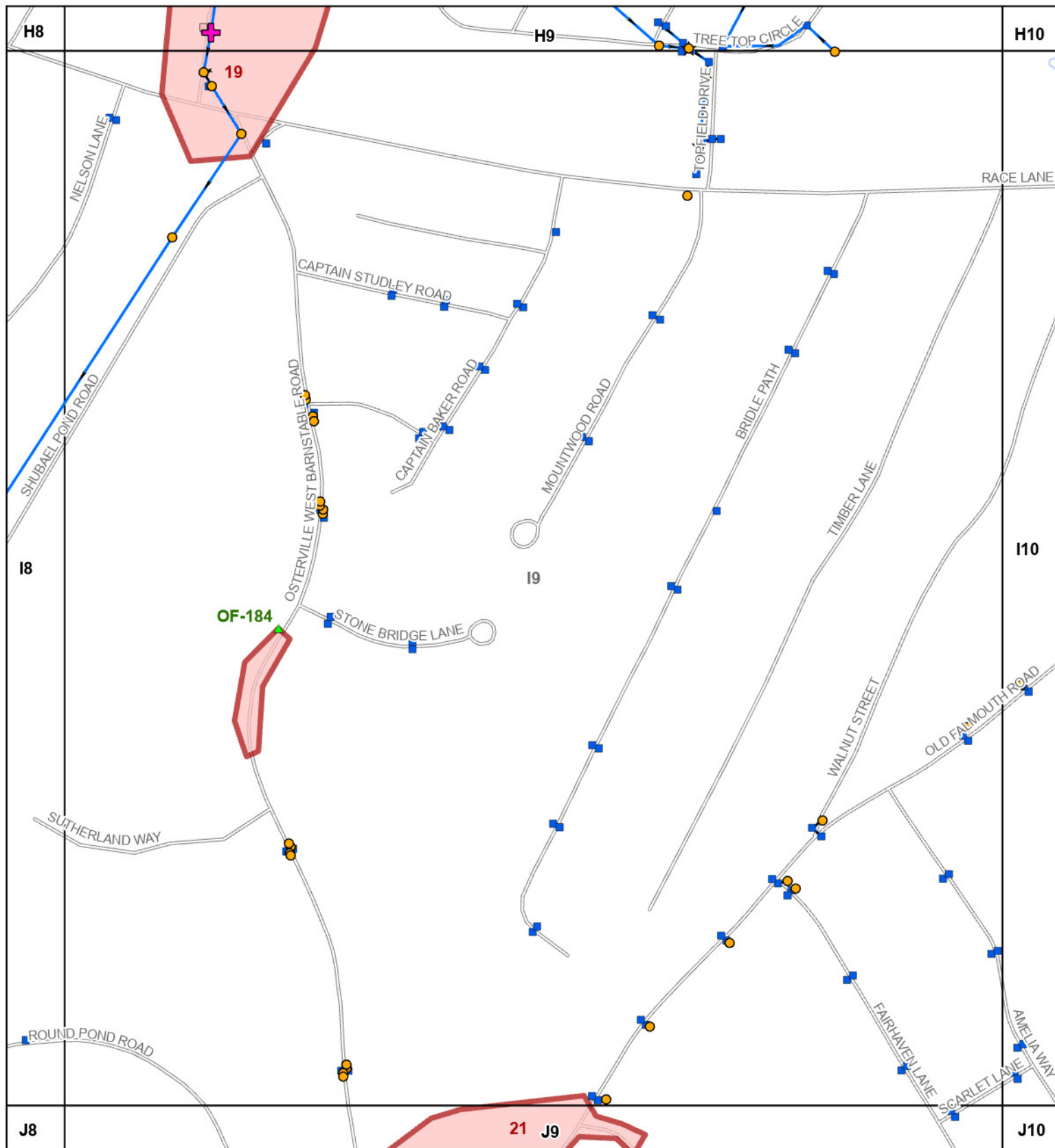
SHEET

I8

0 100 200 300 400 500
Feet



Comprehensive
Environmental
Incorporated



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| ▲ Outfalls | ○ DOT Manhole |
| ■ Catch Basin | ■ DOT Catch Basin |
| ● Drainage Manhole | — Storm Water Gravity Drain |
| ■ Stormwater BMP | — Swale |
| ★ Key Drainage Manhole | — Catchment |
| ✚ Interconnections | — Non-Urban Area |
| △ DOT Outfall | |

Stormwater Infrastructure Map Barnstable, MA

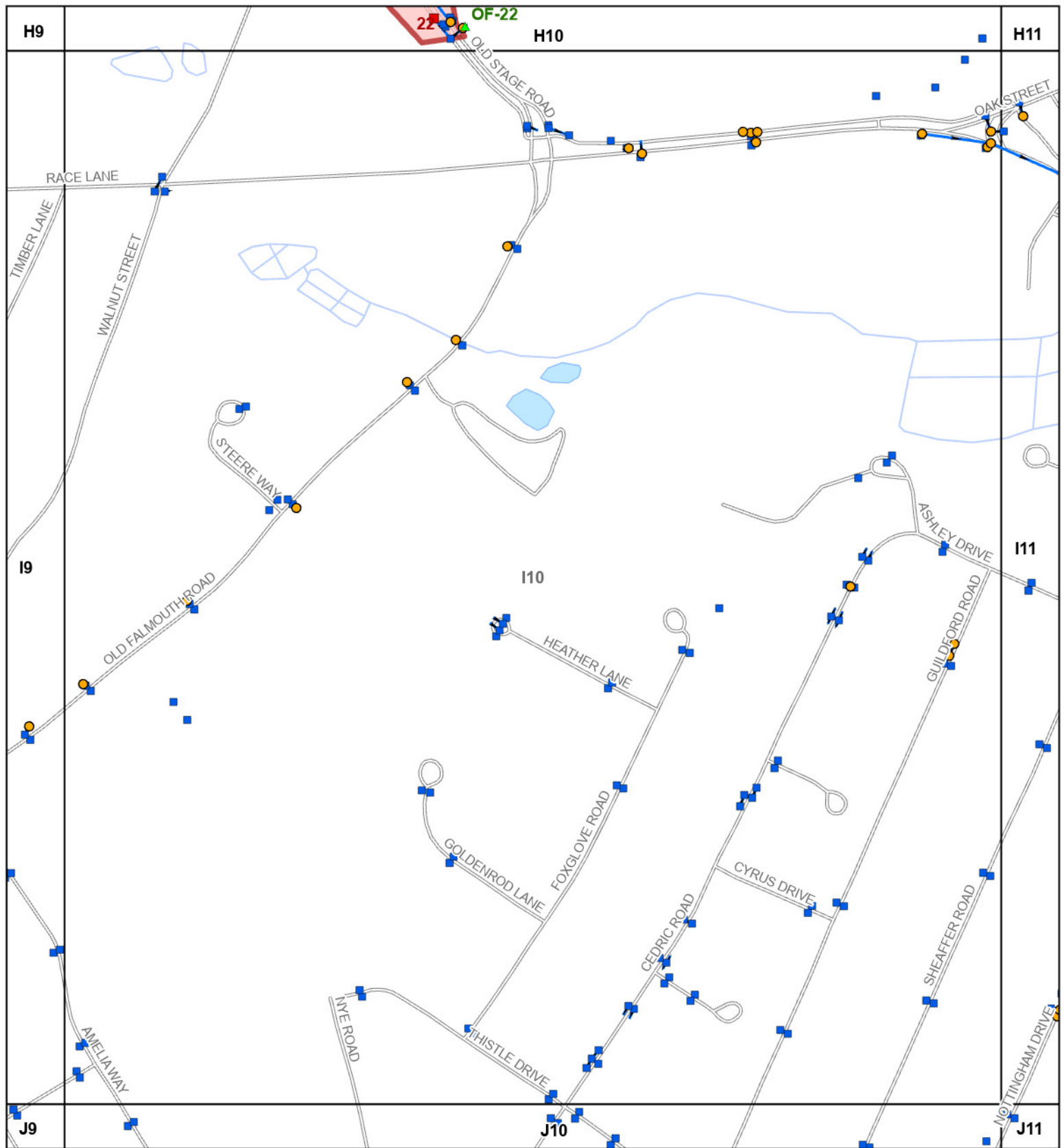
SHEET

I9

0 100 200 300 400 500
Feet



Comprehensive
Environmental
Incorporated



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| ▲ Outfalls | ● DOT Manhole |
| ■ Catch Basin | ■ DOT Catch Basin |
| ● Drainage Manhole | — Storm Water Gravity Drain |
| ■ Stormwater BMP | — Swale |
| ★ Key Drainage Manhole | — Catchment |
| ✚ Interconnections | — Non-Urban Area |
| ▲ DOT Outfall | |

Stormwater Infrastructure Map Barnstable, MA

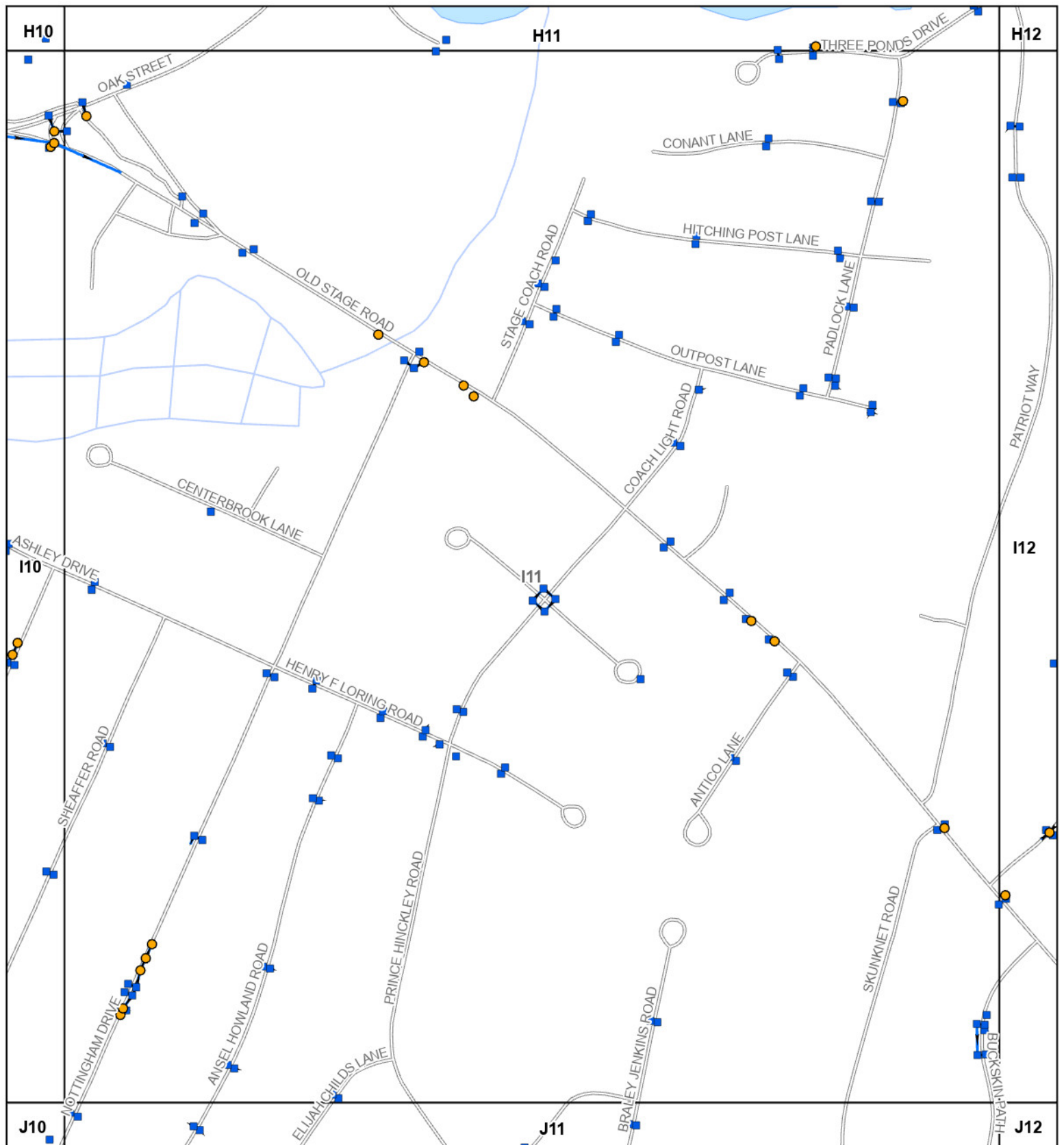
SHEET

I10

0 100 200 300 400 500
Feet



Comprehensive
Environmental
Incorporated



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| ▲ Outfalls | ● DOT Manhole |
| ■ Catch Basin | ■ DOT Catch Basin |
| ● Drainage Manhole | — Storm Water Gravity Drain |
| ■ Stormwater BMP | ~ Swale |
| ★ Key Drainage Manhole | ⬮ Catchment |
| ✚ Interconnections | ☁ Non-Urban Area |
| ▲ DOT Outfall | |

Stormwater Infrastructure Map Barnstable, MA

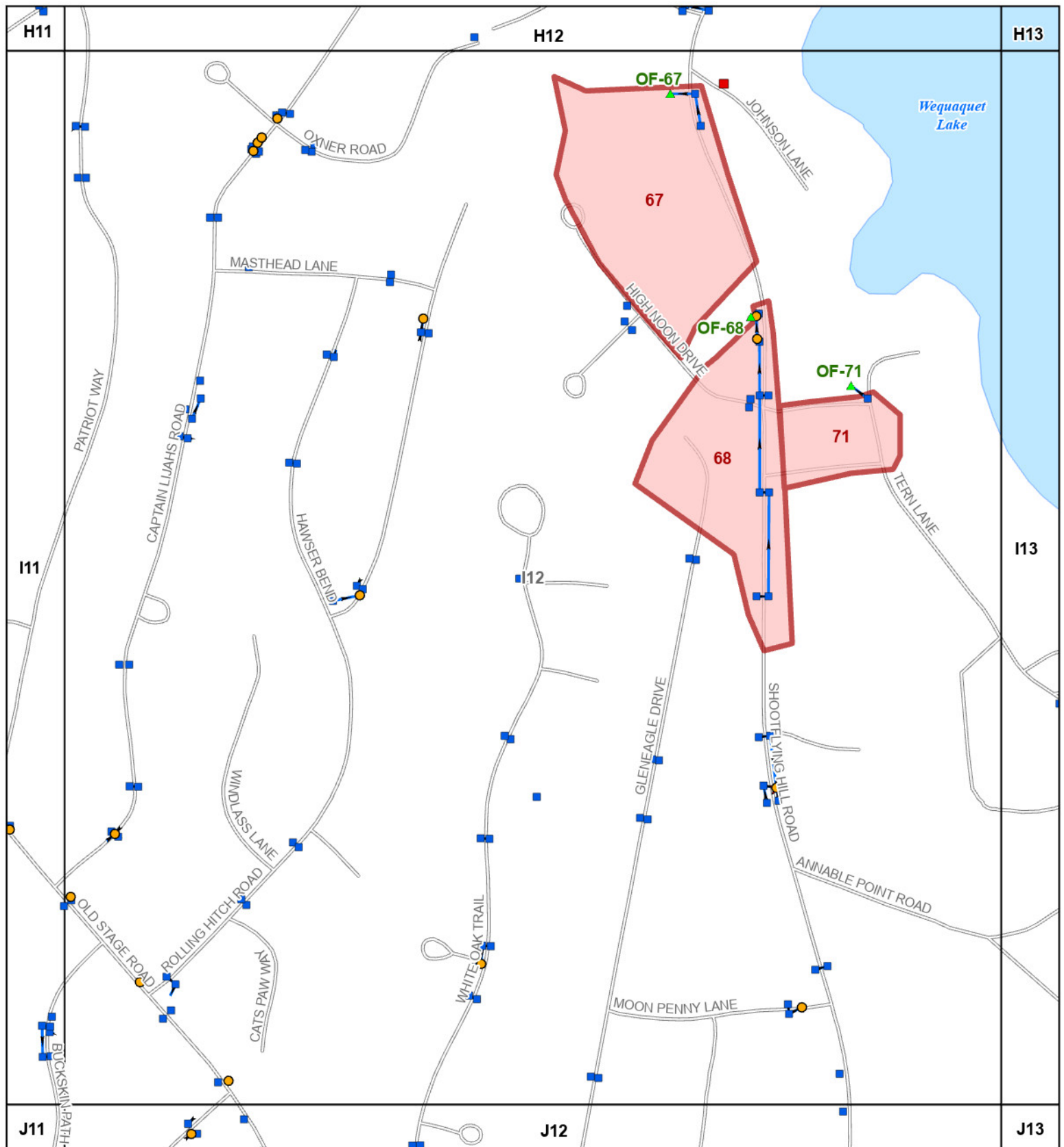
SHEET

I11

0 100 200 300 400 500
Feet



Comprehensive
Environmental
Incorporated



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| ■ Catch Basin | ■ DOT Catch Basin |
| ● Drainage Manhole | — Storm Water Gravity Drain |
| ■ Stormwater BMP | — Swale |
| ★ Key Drainage Manhole | — Catchment |
| ✚ Interconnections | — Non-Urban Area |
| ▲ DOT Outfall | |

Stormwater Infrastructure Map Barnstable, MA

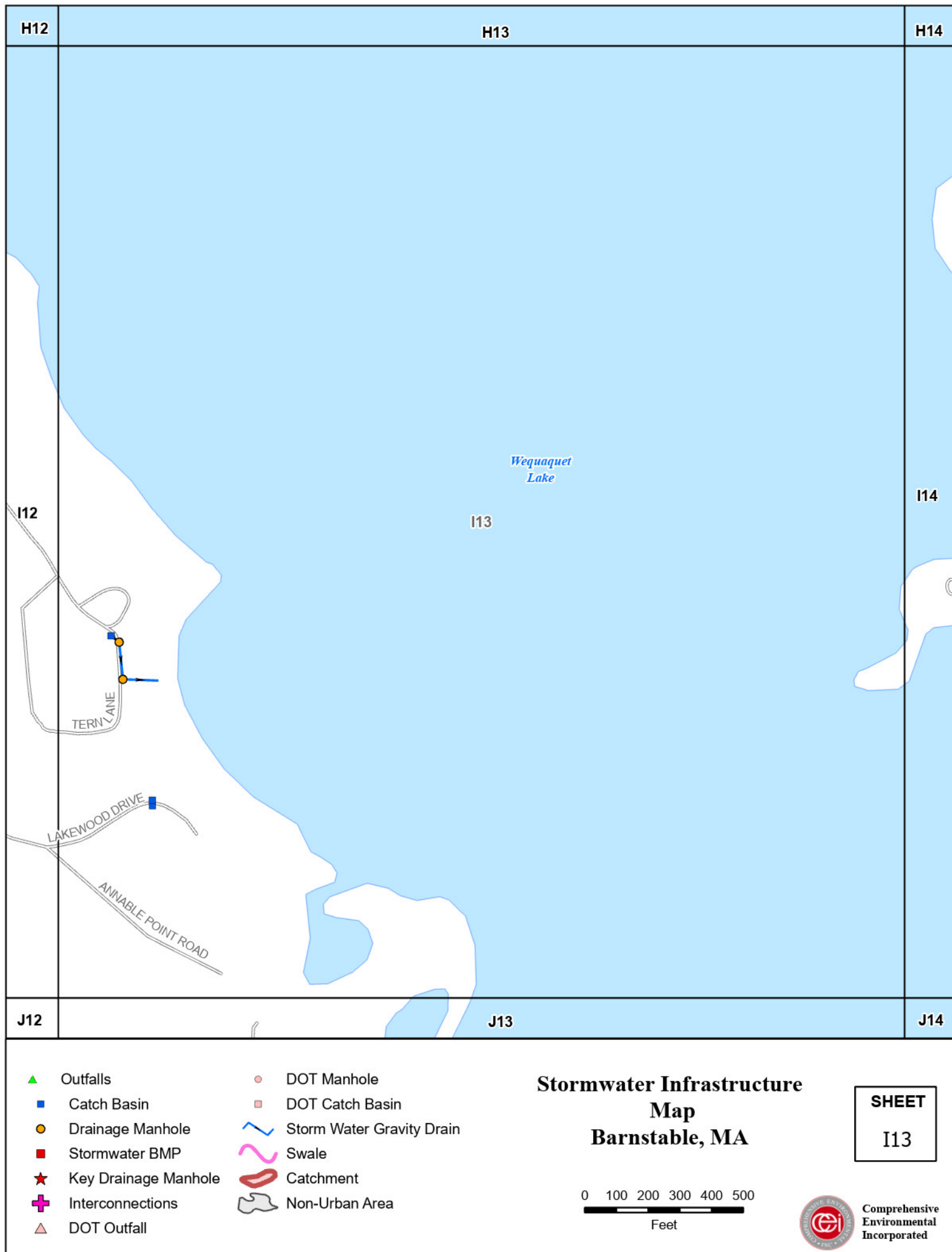
SHEET

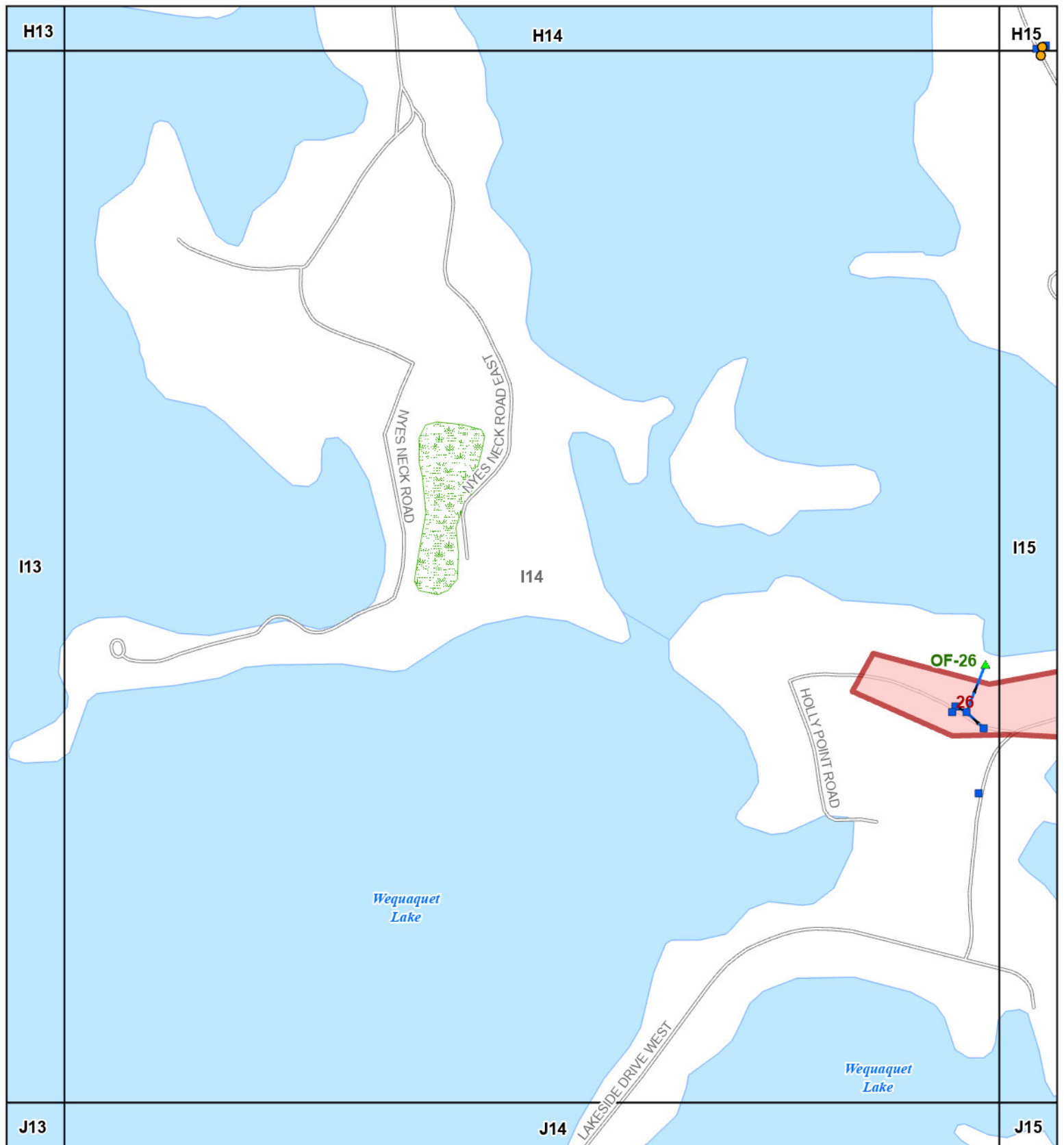
I12

0 100 200 300 400 500
Feet



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Environmental
Incorporated



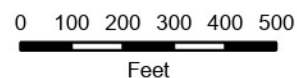


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| ▲ Outfalls | ● DOT Manhole |
| ■ Catch Basin | ■ DOT Catch Basin |
| ● Drainage Manhole | — Storm Water Gravity Drain |
| ■ Stormwater BMP | — Swale |
| ★ Key Drainage Manhole | — Catchment |
| ✚ Interconnections | — Non-Urban Area |
| ▲ DOT Outfall | |

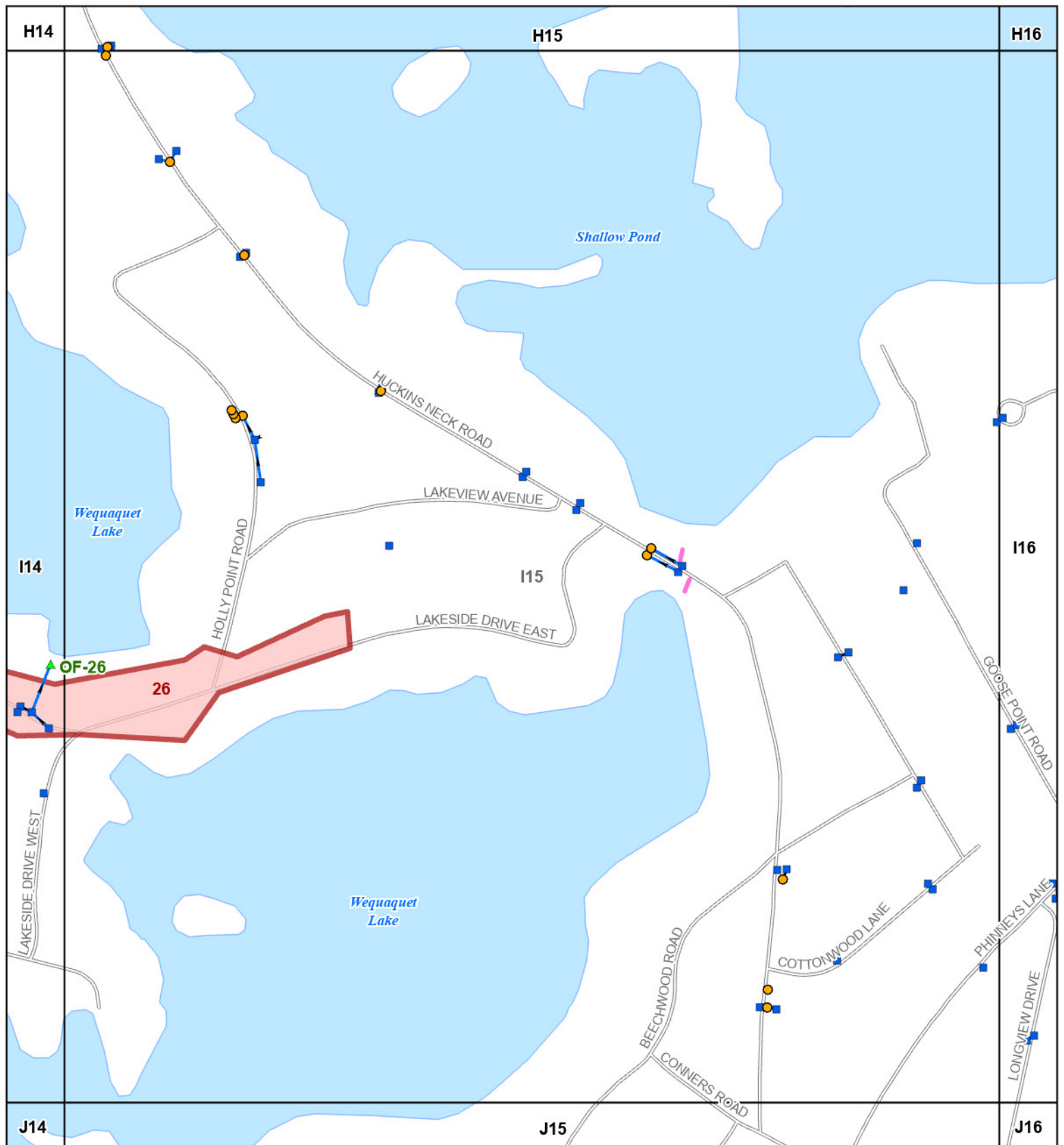
Stormwater Infrastructure Map Barnstable, MA

SHEET

I14



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| ▲ Outfalls | ● DOT Manhole |
| ■ Catch Basin | ■ DOT Catch Basin |
| ● Drainage Manhole | — Storm Water Gravity Drain |
| ■ Stormwater BMP | — Swale |
| ★ Key Drainage Manhole | — Catchment |
| ✚ Interconnections | — Non-Urban Area |
| ▲ DOT Outfall | |

Stormwater Infrastructure Map Barnstable, MA

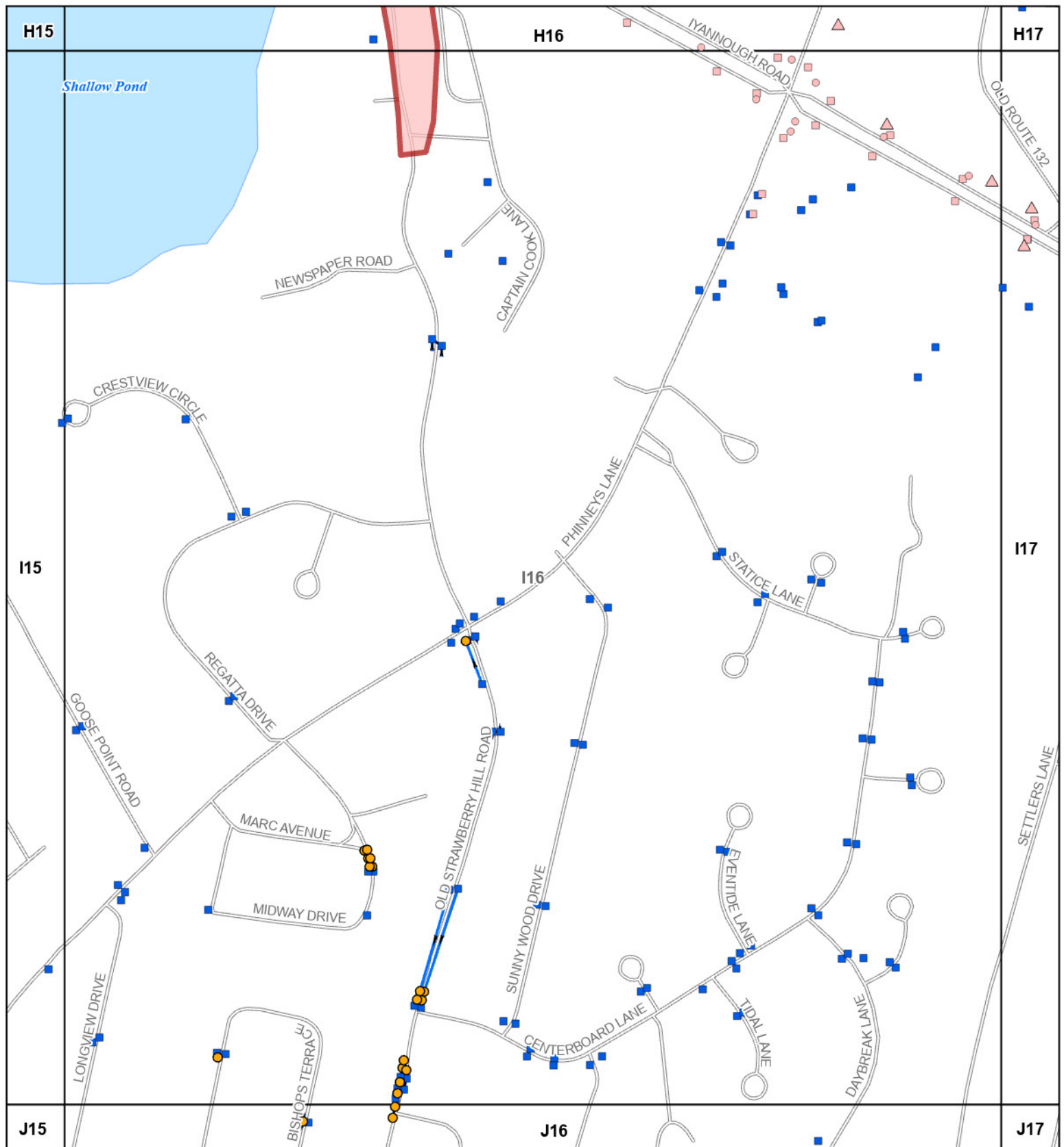
SHEET

I15

0 100 200 300 400 500
Feet



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Environmental
Incorporated



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| ▲ Outfalls | ● DOT Manhole |
| ■ Catch Basin | ■ DOT Catch Basin |
| ● Drainage Manhole | — Storm Water Gravity Drain |
| ■ Stormwater BMP | — Swale |
| ★ Key Drainage Manhole | — Catchment |
| ✚ Interconnections | — Non-Urban Area |
| ▲ DOT Outfall | |

Stormwater Infrastructure Map Barnstable, MA

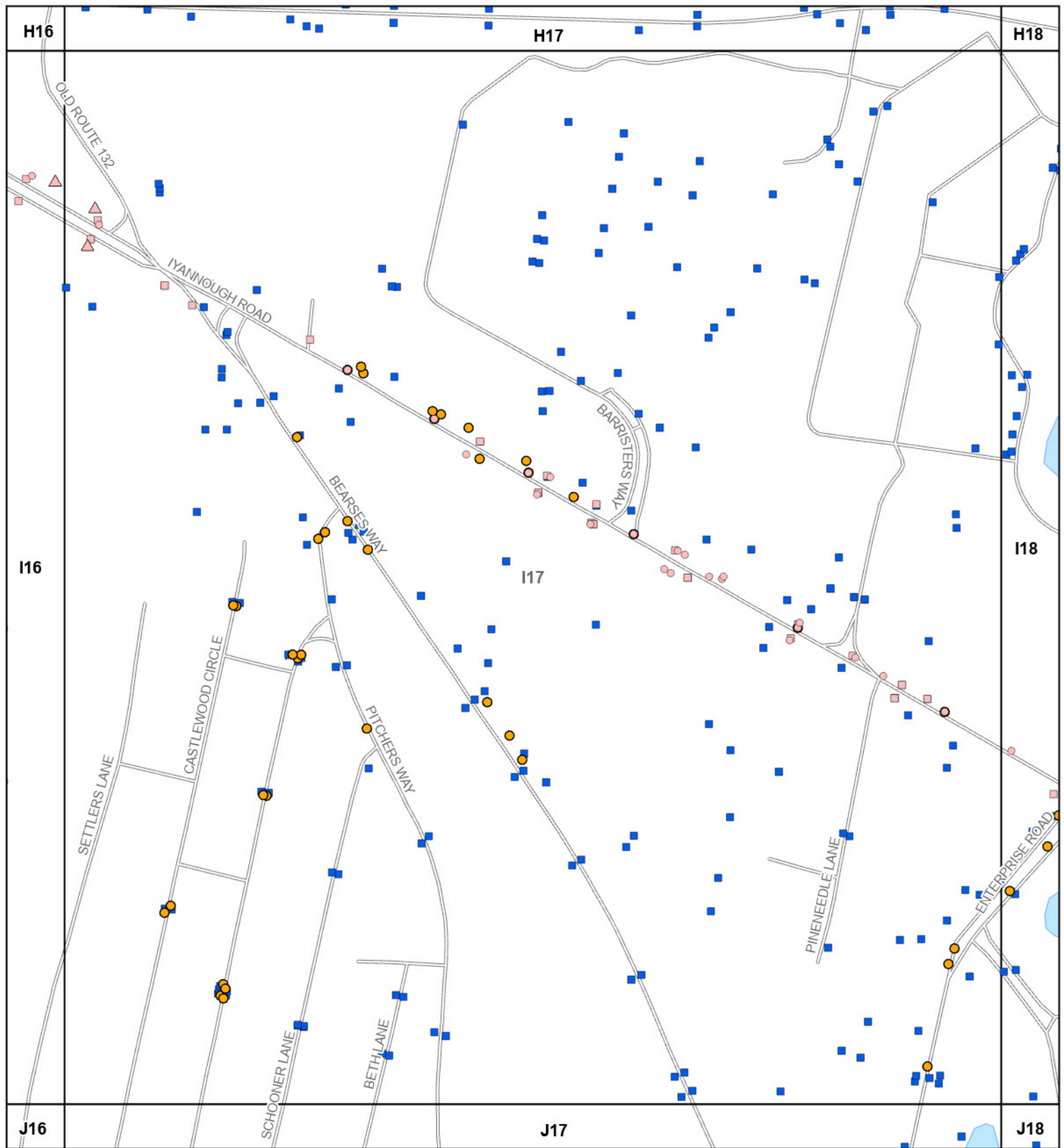
SHEET

I16

0 100 200 300 400 500
Feet



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Environmental
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| ▲ Outfalls | ● DOT Manhole |
| ■ Catch Basin | ■ DOT Catch Basin |
| ● Drainage Manhole | — Storm Water Gravity Drain |
| ■ Stormwater BMP | — Swale |
| ★ Key Drainage Manhole | — Catchment |
| ✚ Interconnections | — Non-Urban Area |
| ▲ DOT Outfall | |

Stormwater Infrastructure Map Barnstable, MA

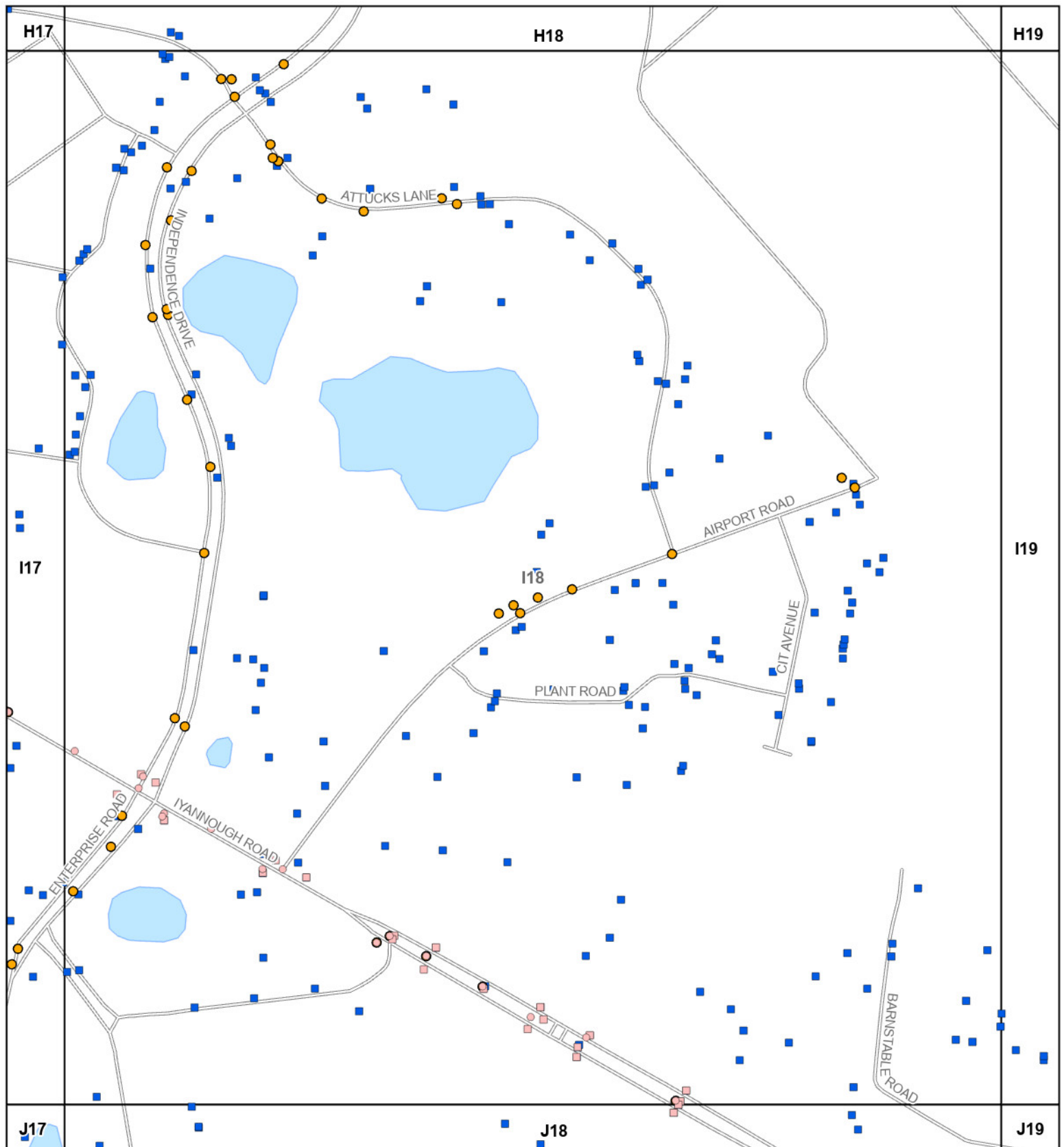
SHEET

I17

0 100 200 300 400 500
Feet



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Environmental
Incorporated



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| ▲ Outfalls | ○ DOT Manhole |
| ■ Catch Basin | ■ DOT Catch Basin |
| ● Drainage Manhole | — Storm Water Gravity Drain |
| ■ Stormwater BMP | — Swale |
| ★ Key Drainage Manhole | — Catchment |
| ✚ Interconnections | — Non-Urban Area |
| △ DOT Outfall | |

Stormwater Infrastructure Map Barnstable, MA

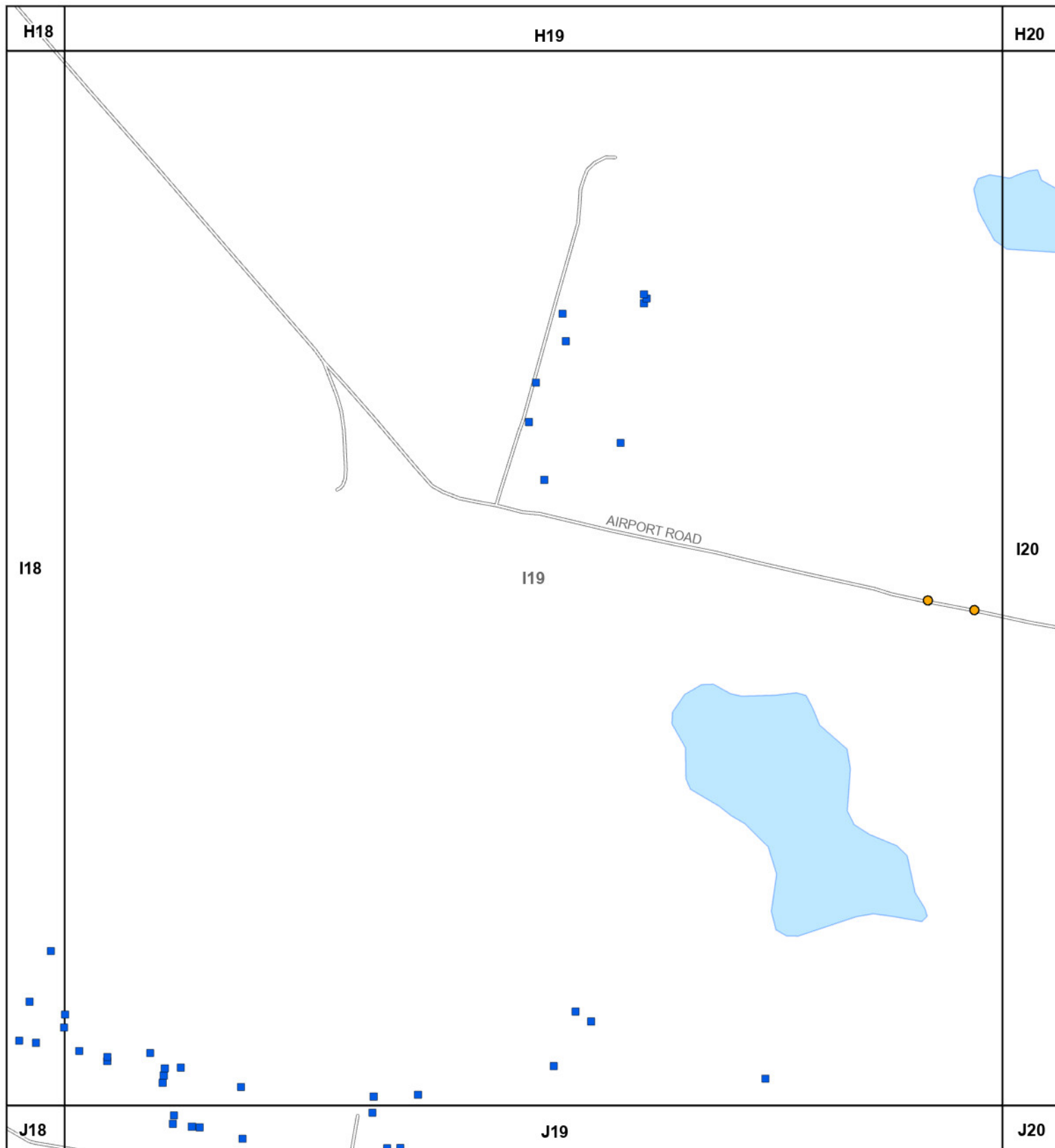
SHEET

I18

0 100 200 300 400 500
Feet



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Environmental
Incorporated



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| ▲ Outfalls | ○ DOT Manhole |
| ■ Catch Basin | ■ DOT Catch Basin |
| ● Drainage Manhole | — Storm Water Gravity Drain |
| ■ Stormwater BMP | — Swale |
| ★ Key Drainage Manhole | — Catchment |
| ✚ Interconnections | — Non-Urban Area |
| △ DOT Outfall | |

Stormwater Infrastructure Map Barnstable, MA

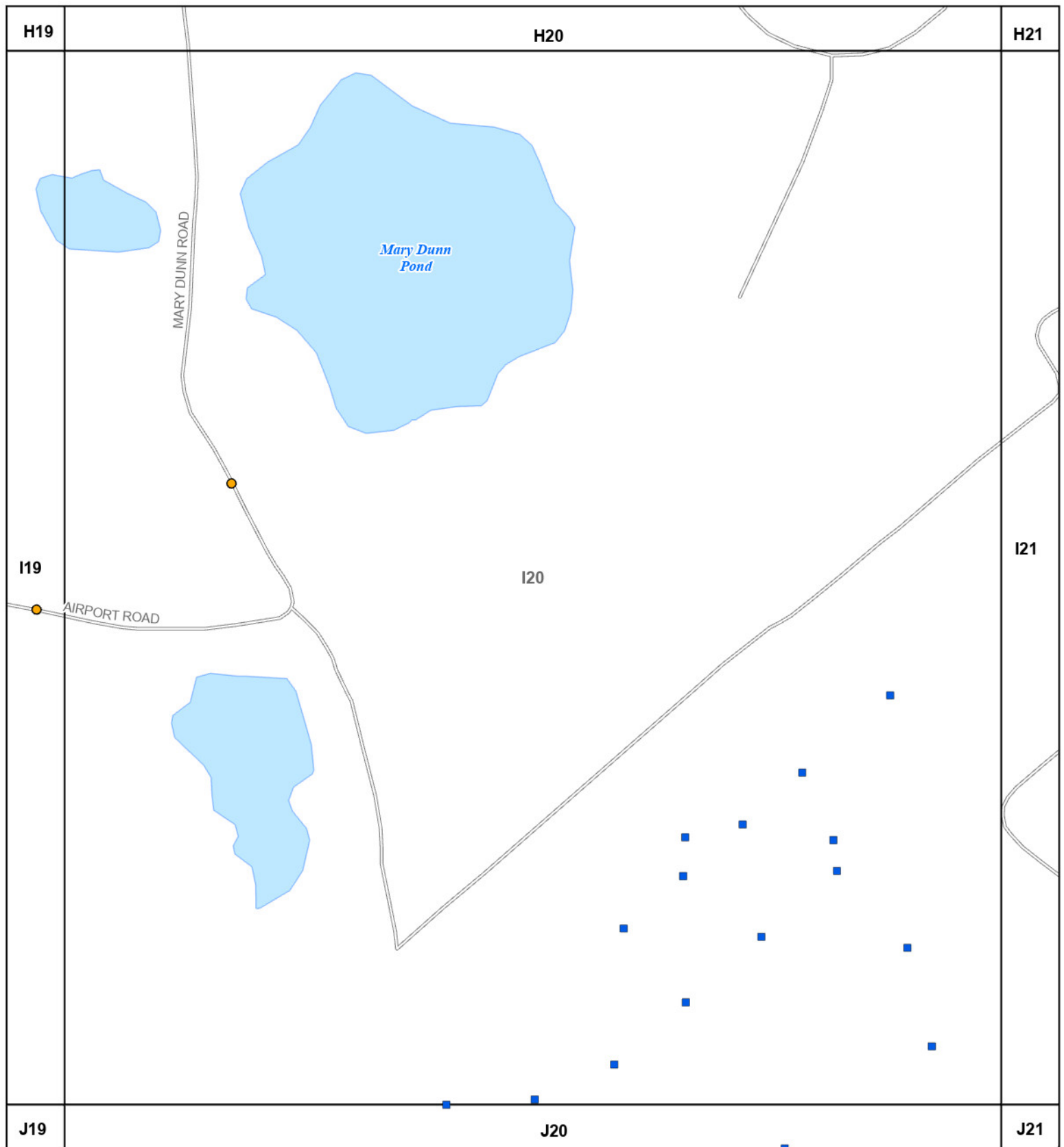
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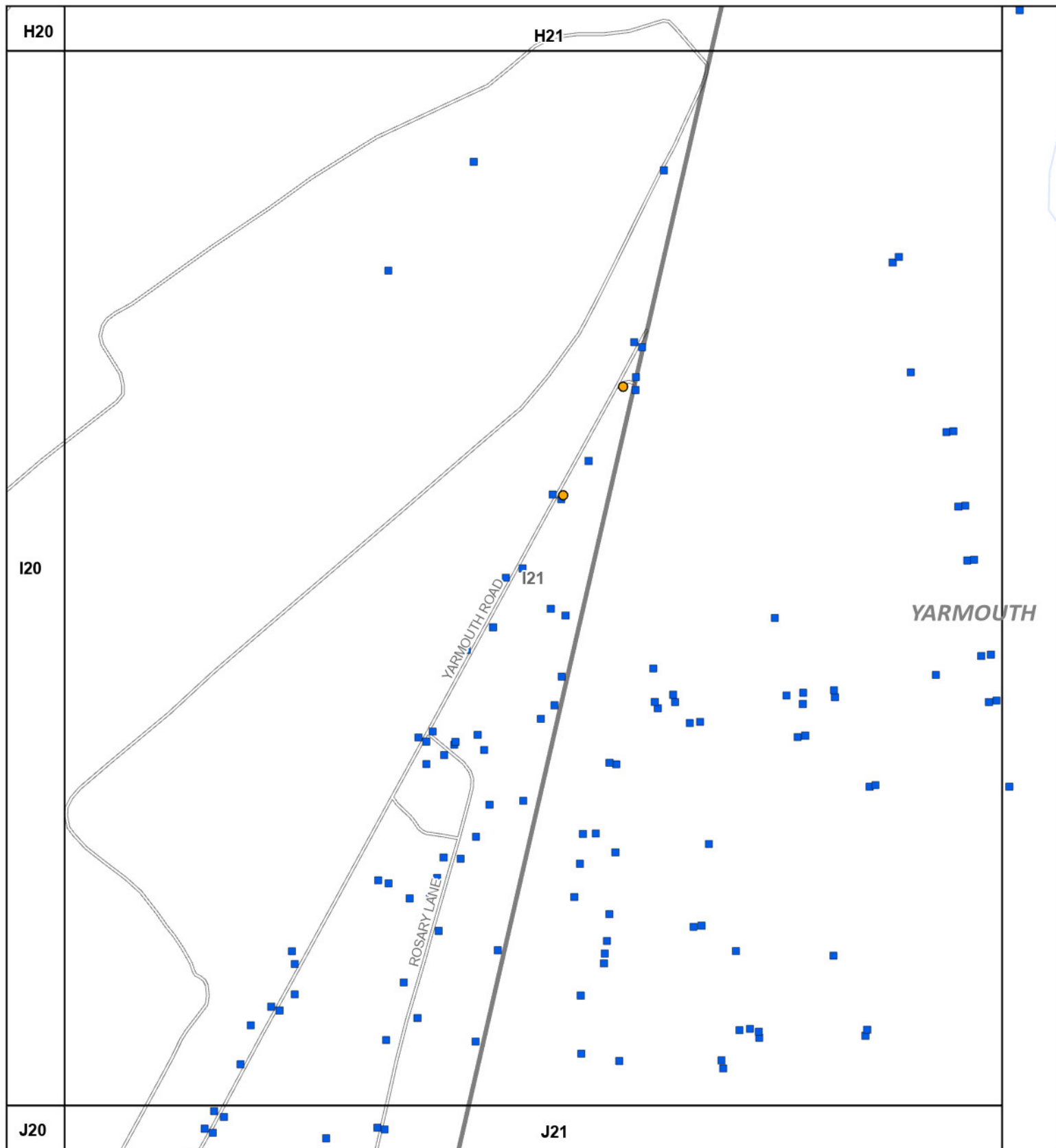
I19

0 100 200 300 400 500
Feet



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| ▲ Outfalls | ○ DOT Manhole |
| ■ Catch Basin | ■ DOT Catch Basin |
| ● Drainage Manhole | — Storm Water Gravity Drain |
| ■ Stormwater BMP | — Swale |
| ★ Key Drainage Manhole | — Catchment |
| ✚ Interconnections | — Non-Urban Area |
| △ DOT Outfall | |

Stormwater Infrastructure Map Barnstable, MA

SHEET

I21

0 100 200 300 400 500
Feet



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Environmental
Incorporated

J1

J2

GALLAGHER LANE

WAKEBY ROAD

MASHPEE

K2

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| ▲ Outfalls | ○ DOT Manhole |
| ■ Catch Basin | ■ DOT Catch Basin |
| ● Drainage Manhole | — Storm Water Gravity Drain |
| ■ Stormwater BMP | — Swale |
| ★ Key Drainage Manhole | — Catchment |
| ✚ Interconnections | — Non-Urban Area |
| △ DOT Outfall | |

Stormwater Infrastructure Map Barnstable, MA

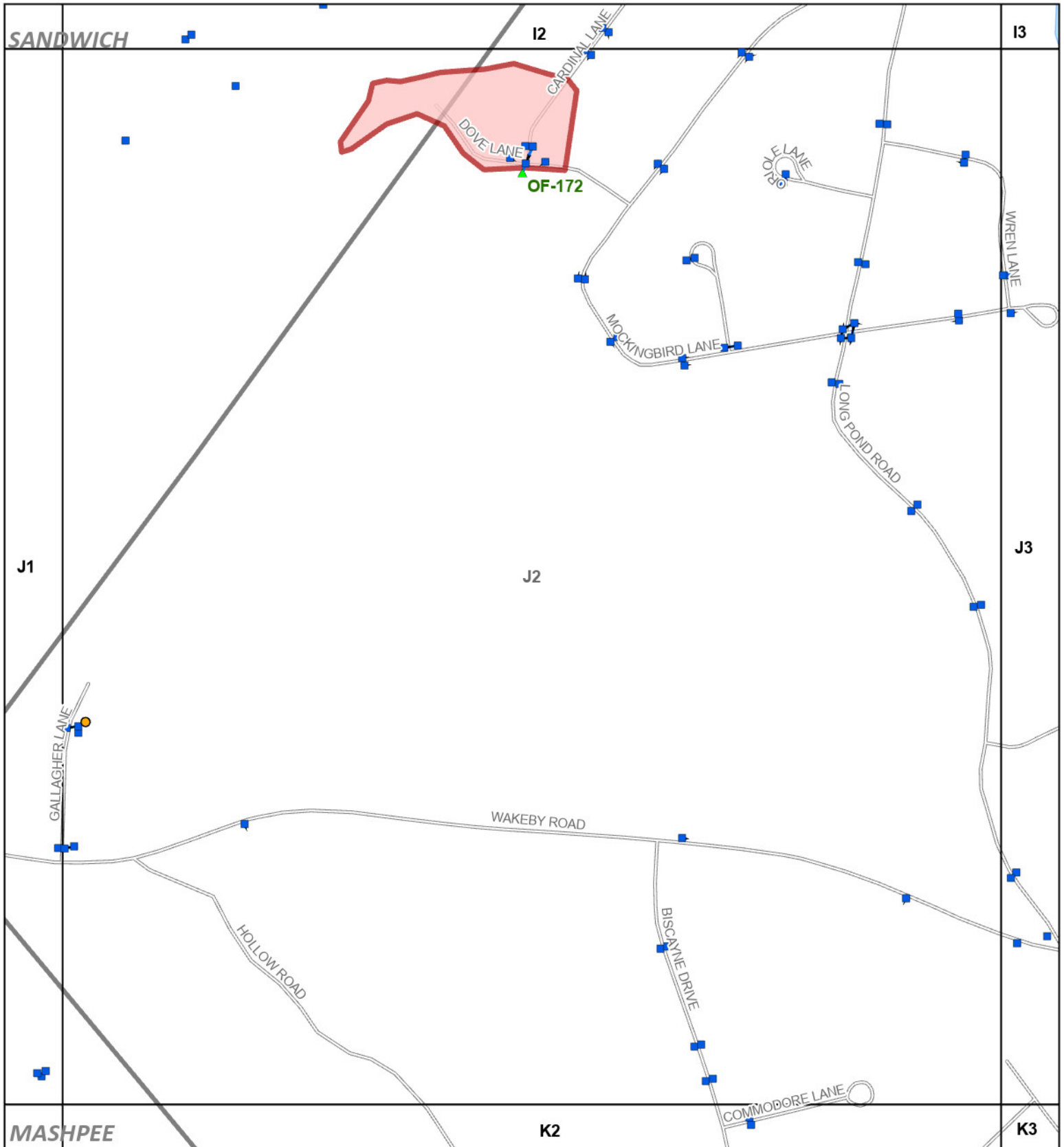
SHEET

J1

0 100 200 300 400 500
Feet



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Incorporated



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| ▲ Outfalls | ○ DOT Manhole |
| ■ Catch Basin | ■ DOT Catch Basin |
| ● Drainage Manhole | — Storm Water Gravity Drain |
| ■ Stormwater BMP | — Swale |
| ★ Key Drainage Manhole | — Catchment |
| ✚ Interconnections | — Non-Urban Area |
| △ DOT Outfall | |

Stormwater Infrastructure Map Barnstable, MA

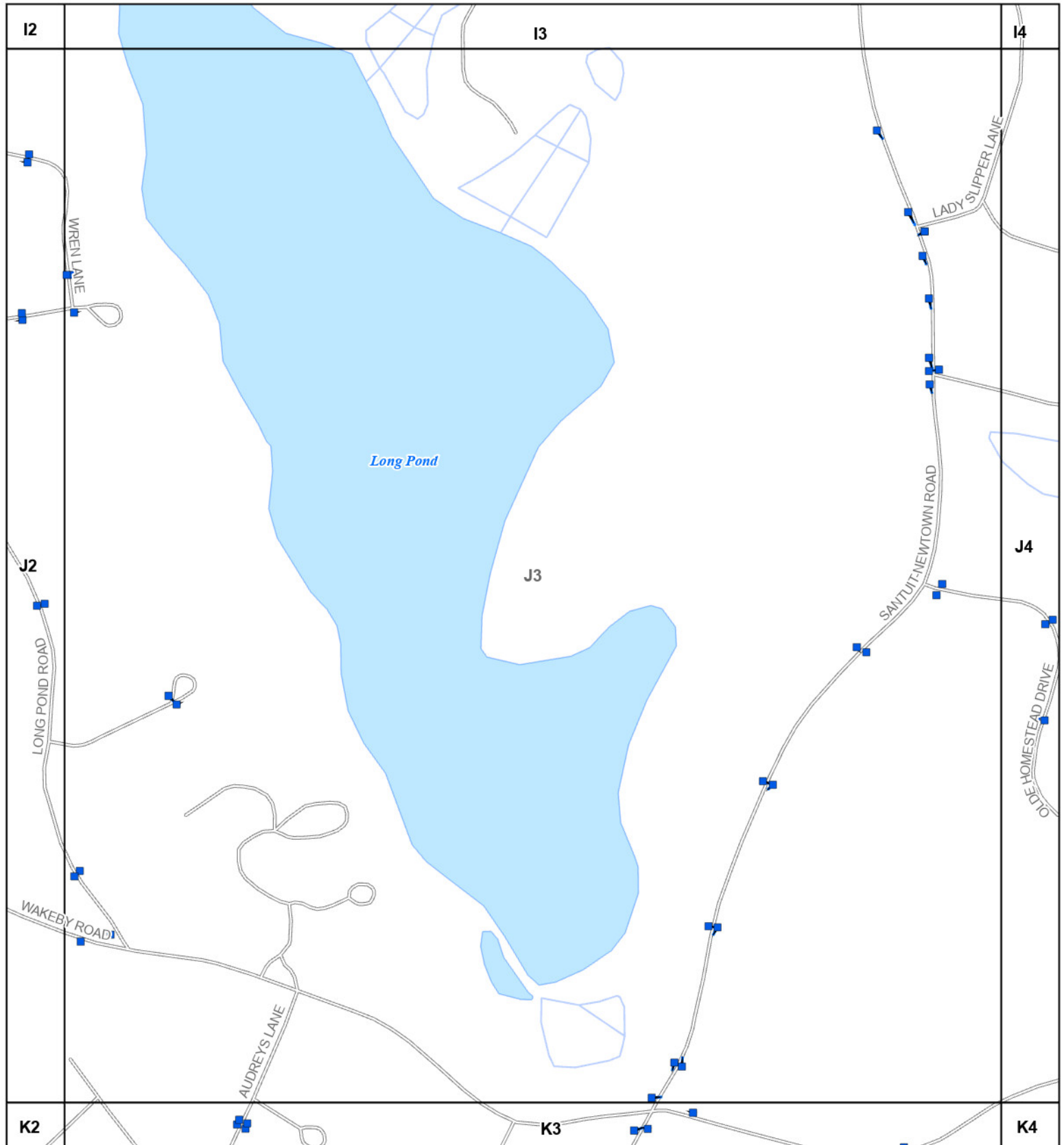
SHEET

J2

0 100 200 300 400 500
Feet



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Environmental
Incorporated



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| ■ Catch Basin | ■ DOT Catch Basin |
| ● Drainage Manhole | — Storm Water Gravity Drain |
| ■ Stormwater BMP | — Swale |
| ★ Key Drainage Manhole | — Catchment |
| ✚ Interconnections | — Non-Urban Area |
| △ DOT Outfall | |

Stormwater Infrastructure Map Barnstable, MA

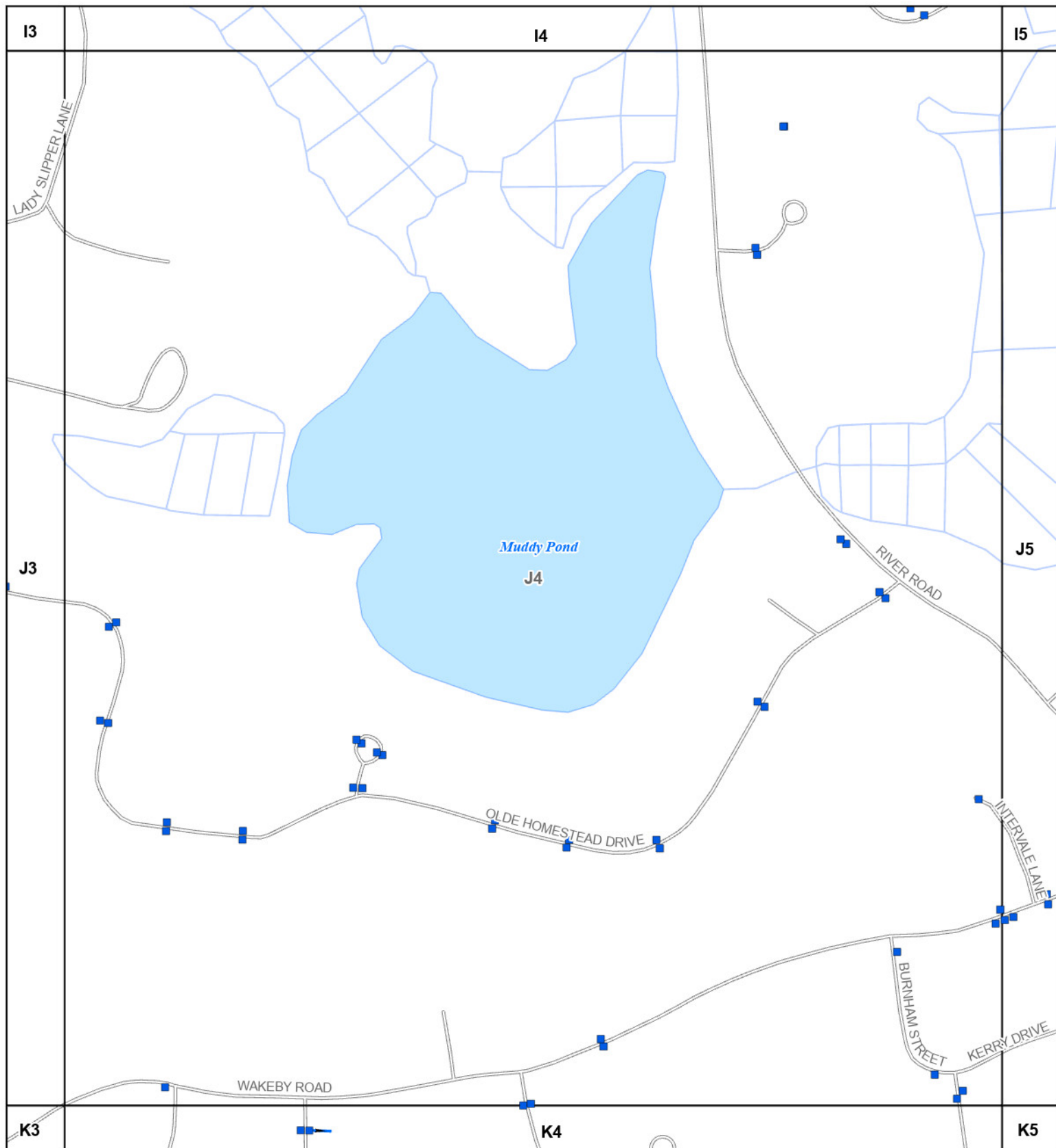
SHEET

J3

0 100 200 300 400 500
Feet



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Environmental
Incorporated



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| ▲ Outfalls | ○ DOT Manhole |
| ■ Catch Basin | ■ DOT Catch Basin |
| ● Drainage Manhole | — Storm Water Gravity Drain |
| ■ Stormwater BMP | — Swale |
| ★ Key Drainage Manhole | — Catchment |
| ✚ Interconnections | — Non-Urban Area |
| ▲ DOT Outfall | |

Stormwater Infrastructure Map Barnstable, MA

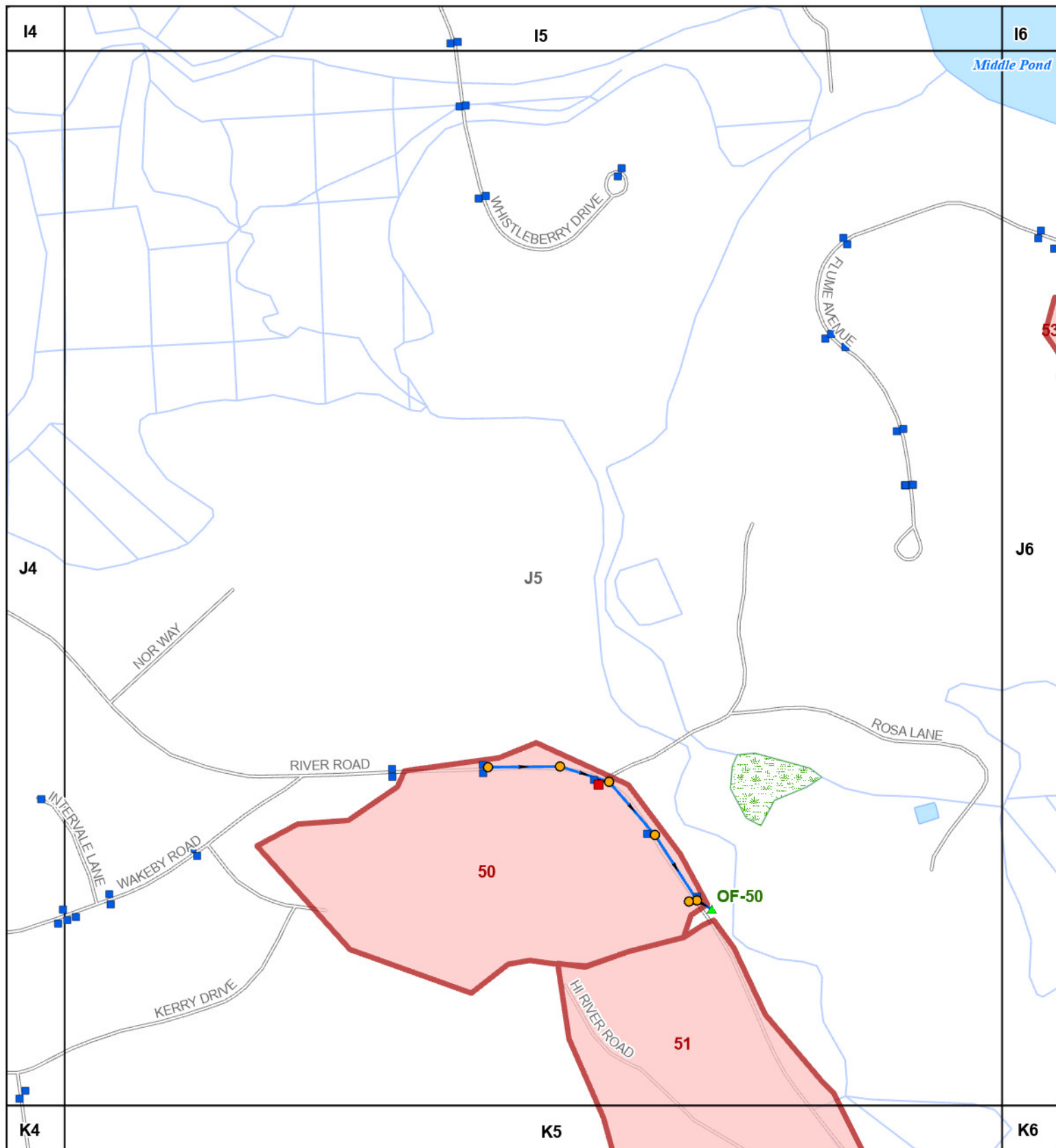
SHEET

J4

0 100 200 300 400 500
Feet



Comprehensive
Environmental
Incorporated



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| ▲ Outfalls | ● DOT Manhole |
| ■ Catch Basin | ■ DOT Catch Basin |
| ● Drainage Manhole | — Storm Water Gravity Drain |
| ■ Stormwater BMP | — Swale |
| ★ Key Drainage Manhole | — Catchment |
| ✚ Interconnections | — Non-Urban Area |
| ▲ DOT Outfall | |

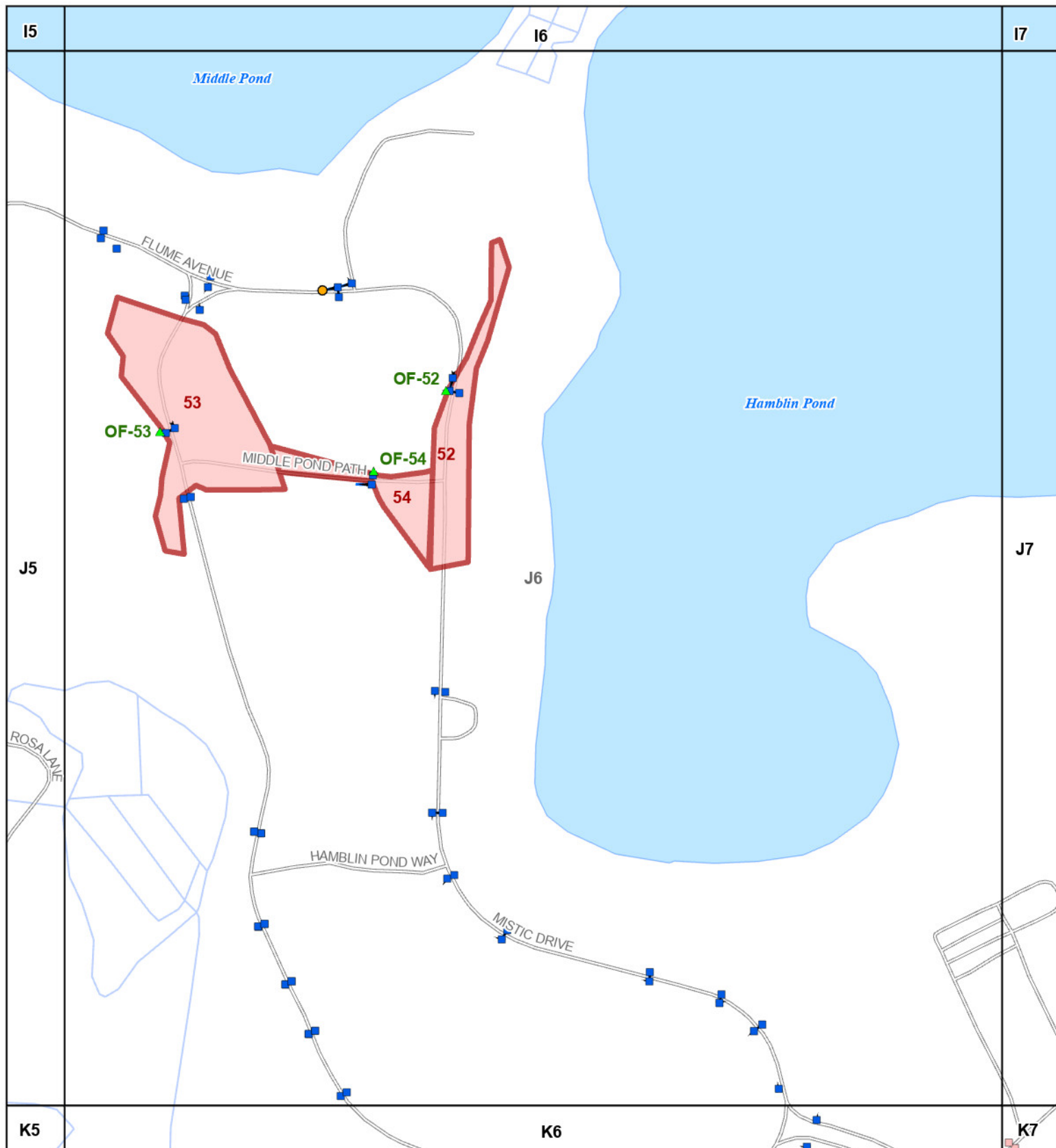
Stormwater Infrastructure Map Barnstable, MA

SHEET
J5

0 100 200 300 400 500
Feet



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Incorporated



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| ▲ Outfalls | ○ DOT Manhole |
| ■ Catch Basin | ■ DOT Catch Basin |
| ● Drainage Manhole | — Storm Water Gravity Drain |
| ■ Stormwater BMP | — Swale |
| ★ Key Drainage Manhole | — Catchment |
| ✚ Interconnections | — Non-Urban Area |
| △ DOT Outfall | |

Stormwater Infrastructure Map Barnstable, MA

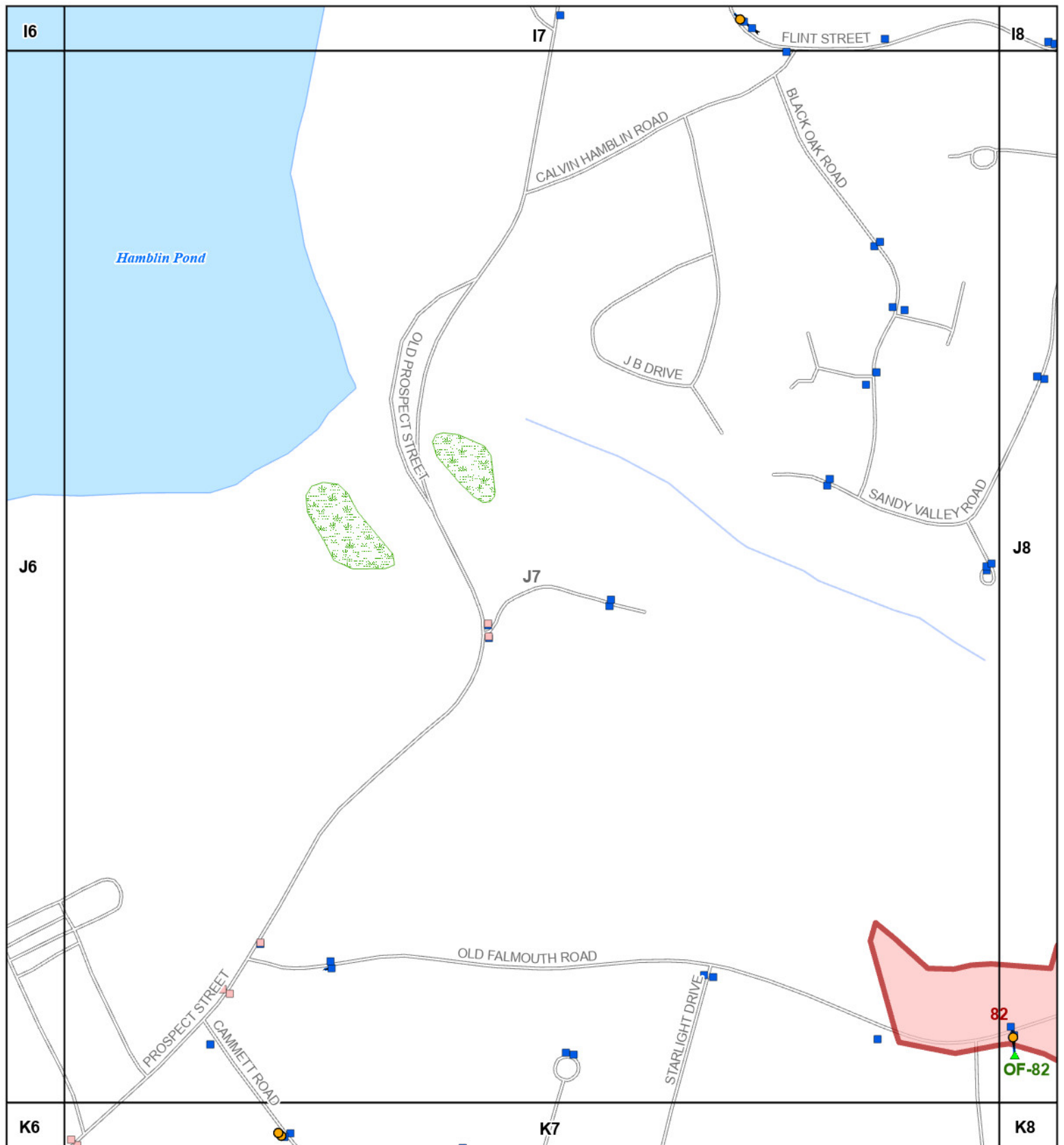
SHEET

J6

0 100 200 300 400 500
Feet



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Environmental
Incorporated



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| ▲ Outfalls | ○ DOT Manhole |
| ■ Catch Basin | ■ DOT Catch Basin |
| ● Drainage Manhole | — Storm Water Gravity Drain |
| ■ Stormwater BMP | ~ Swale |
| ★ Key Drainage Manhole | 🔴 Catchment |
| ✚ Interconnections | 🌿 Non-Urban Area |
| ▲ DOT Outfall | |

Stormwater Infrastructure Map Barnstable, MA

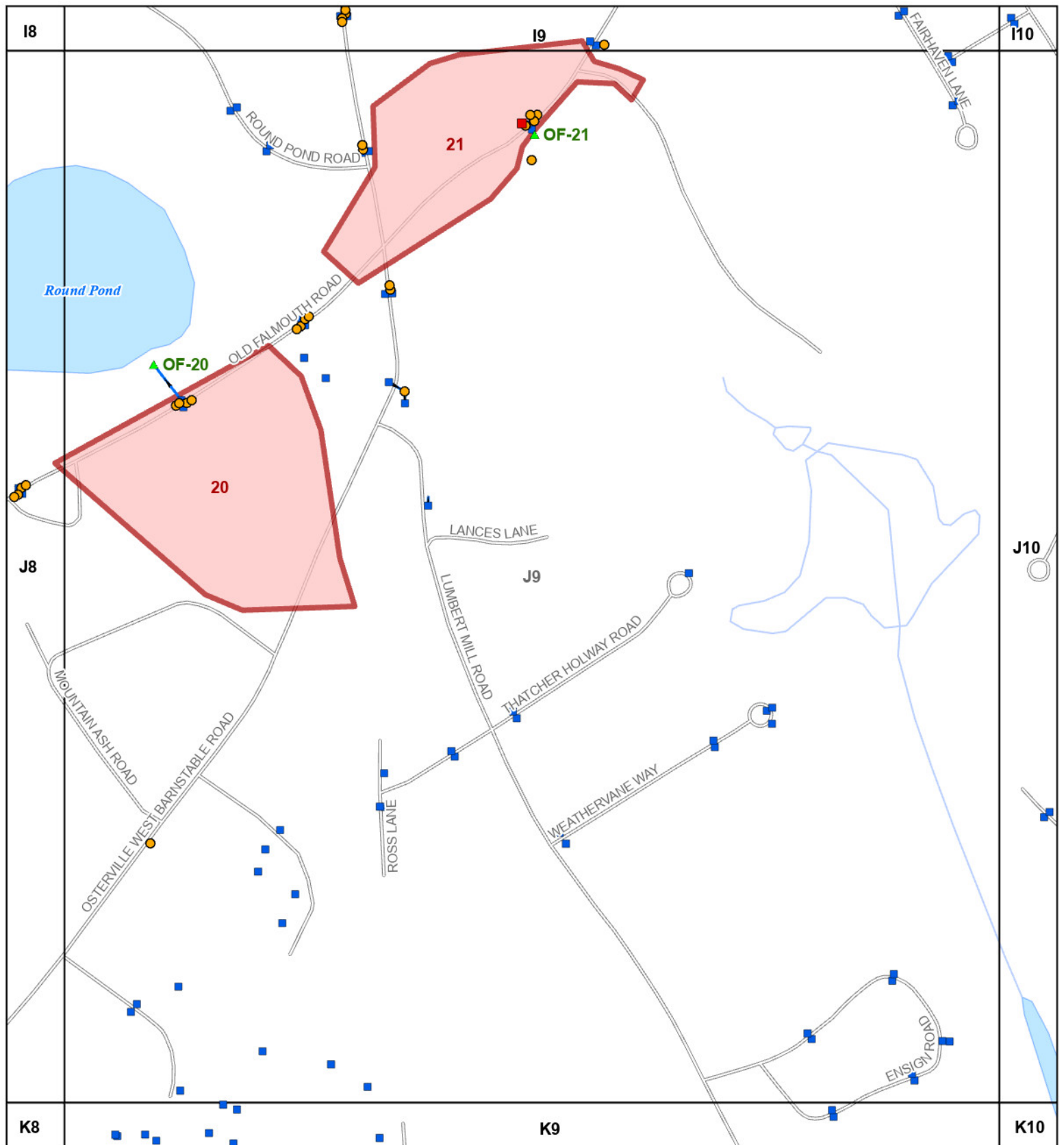
SHEET

J7

0 100 200 300 400 500
Feet



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Environmental
Incorporated



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| ■ Catch Basin | ■ DOT Catch Basin |
| ● Drainage Manhole | — Storm Water Gravity Drain |
| ■ Stormwater BMP | — Swale |
| ★ Key Drainage Manhole | — Catchment |
| ✚ Interconnections | — Non-Urban Area |
| ▲ DOT Outfall | |

Stormwater Infrastructure Map Barnstable, MA

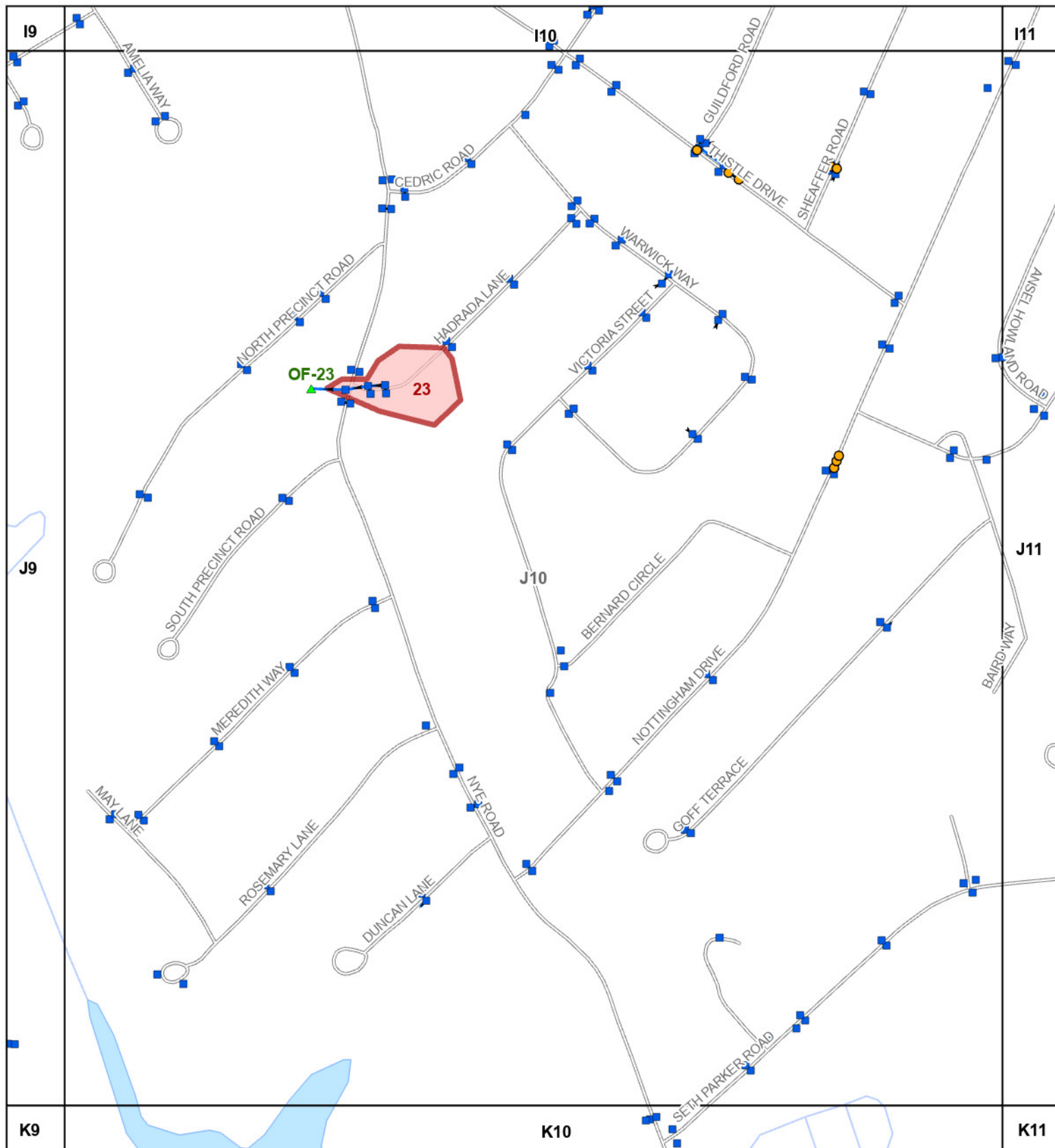
SHEET

J9

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Feet



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Environmental
Incorporated



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| ▲ Outfalls | ○ DOT Manhole |
| ■ Catch Basin | ■ DOT Catch Basin |
| ● Drainage Manhole | — Storm Water Gravity Drain |
| ■ Stormwater BMP | — Swale |
| ★ Key Drainage Manhole | — Catchment |
| ✚ Interconnections | — Non-Urban Area |
| ▲ DOT Outfall | |

Stormwater Infrastructure Map Barnstable, MA

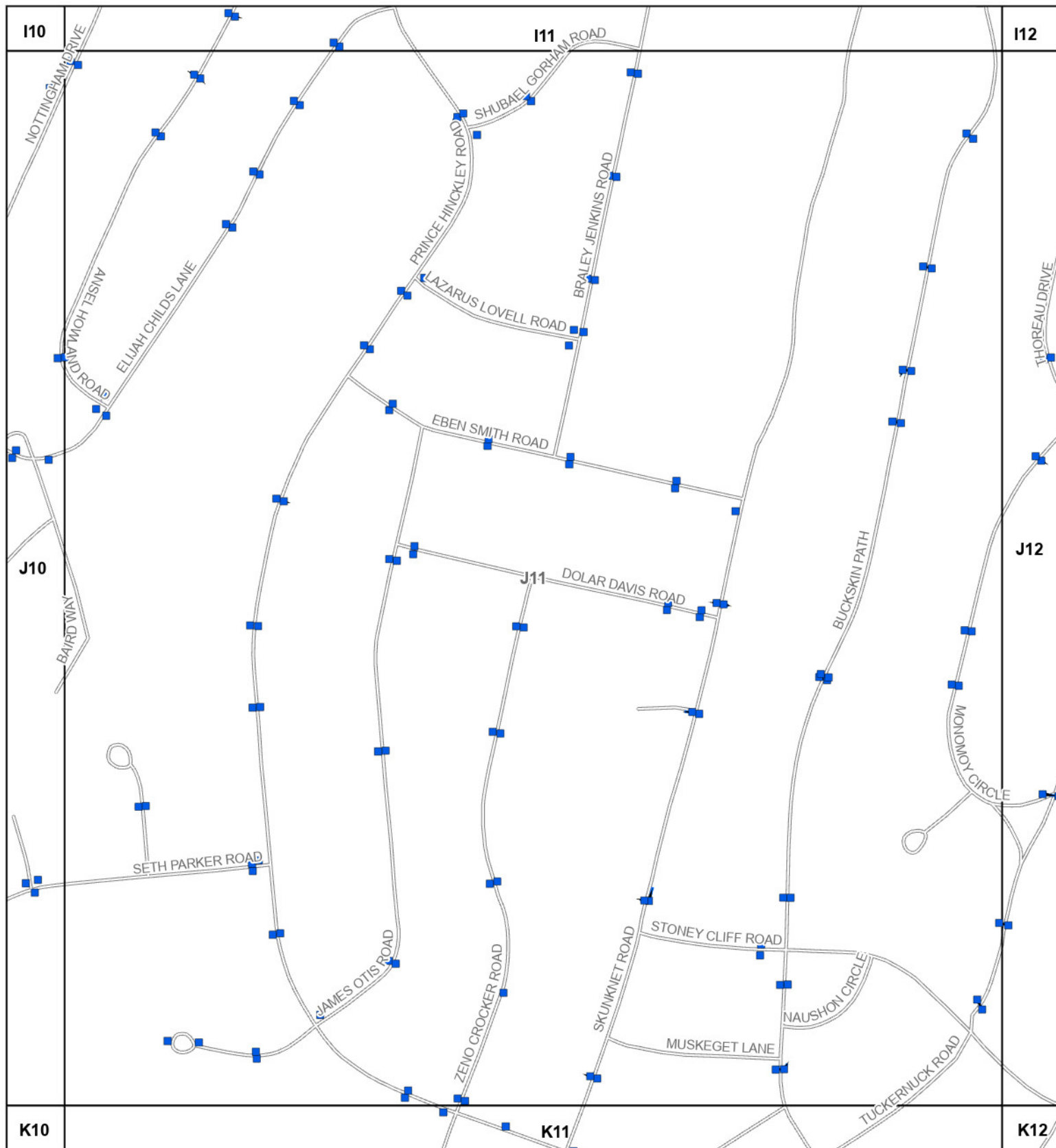
SHEET

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Feet



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Environmental
Incorporated



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| ▲ Outfalls | ○ DOT Manhole |
| ■ Catch Basin | ■ DOT Catch Basin |
| ● Drainage Manhole | — Storm Water Gravity Drain |
| ■ Stormwater BMP | — Swale |
| ★ Key Drainage Manhole | — Catchment |
| ✚ Interconnections | — Non-Urban Area |
| ▲ DOT Outfall | |

Stormwater Infrastructure Map Barnstable, MA

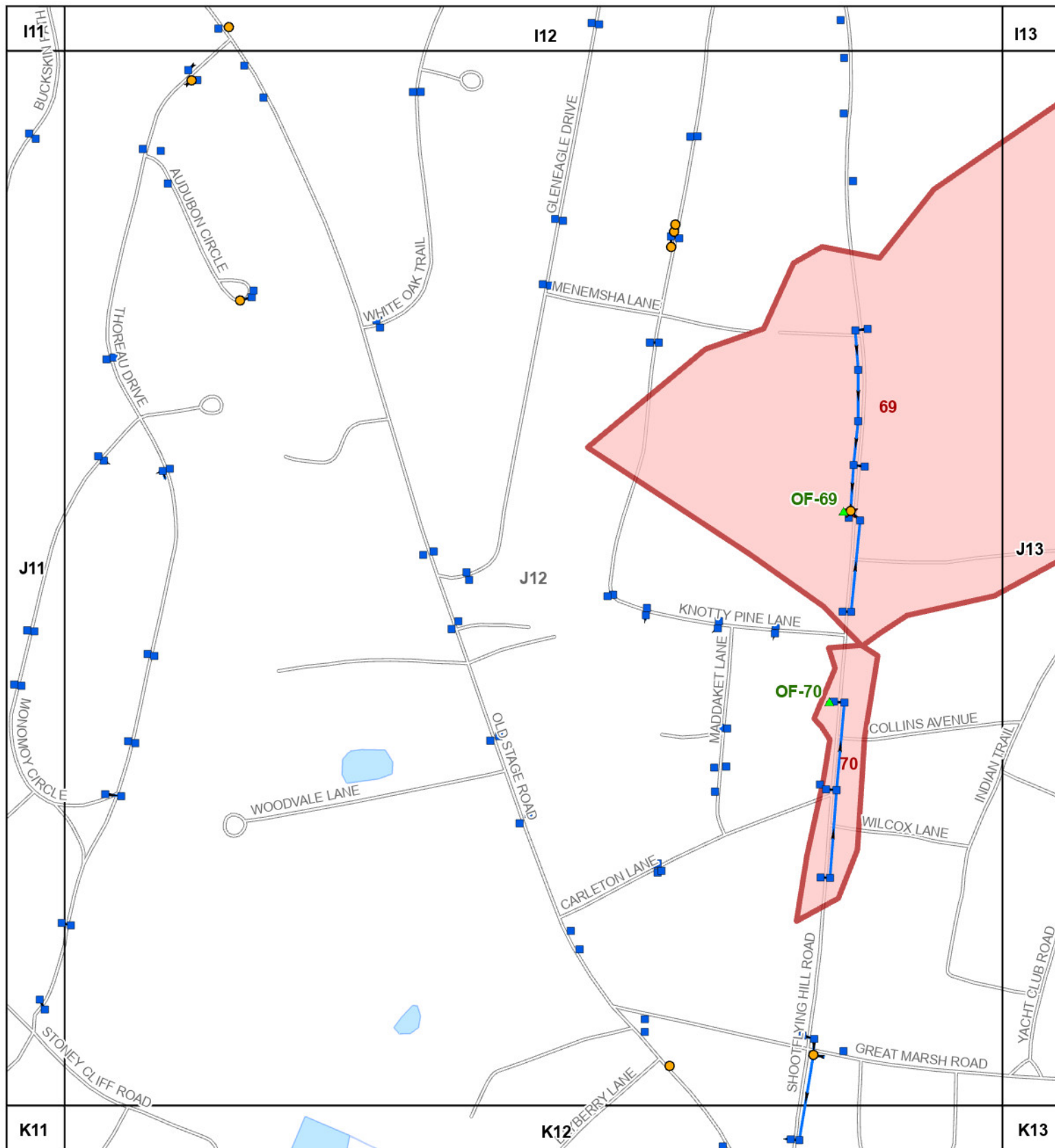
SHEET

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Feet



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Environmental
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| ▲ Outfalls | ○ DOT Manhole |
| ■ Catch Basin | ■ DOT Catch Basin |
| ● Drainage Manhole | — Storm Water Gravity Drain |
| ■ Stormwater BMP | — Swale |
| ★ Key Drainage Manhole | — Catchment |
| ✚ Interconnections | — Non-Urban Area |
| △ DOT Outfall | |

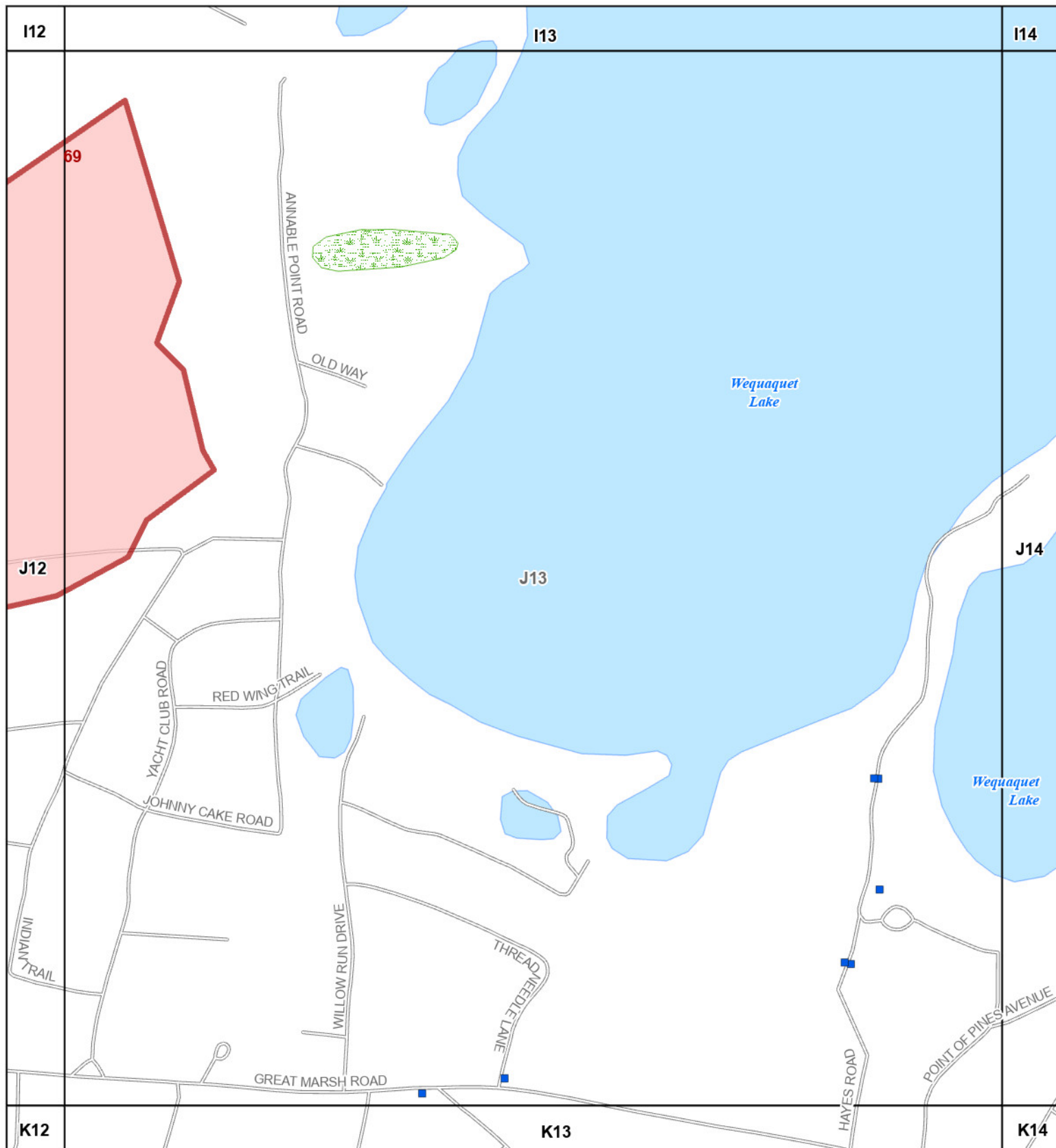
Stormwater Infrastructure Map Barnstable, MA

SHEET
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0 100 200 300 400 500
Feet



Comprehensive
Environmental
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| ▲ Outfalls | ● DOT Manhole |
| ■ Catch Basin | ■ DOT Catch Basin |
| ● Drainage Manhole | — Storm Water Gravity Drain |
| ■ Stormwater BMP | — Swale |
| ★ Key Drainage Manhole | — Catchment |
| ✚ Interconnections | — Non-Urban Area |
| ▲ DOT Outfall | |

Stormwater Infrastructure Map Barnstable, MA

SHEET

J13

0 100 200 300 400 500
Feet



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Environmental
Incorporated



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| ▲ Outfalls | ● DOT Manhole |
| ■ Catch Basin | ■ DOT Catch Basin |
| ● Drainage Manhole | — Storm Water Gravity Drain |
| ■ Stormwater BMP | — Swale |
| ★ Key Drainage Manhole | — Catchment |
| ✚ Interconnections | — Non-Urban Area |
| ▲ DOT Outfall | |

Stormwater Infrastructure Map Barnstable, MA

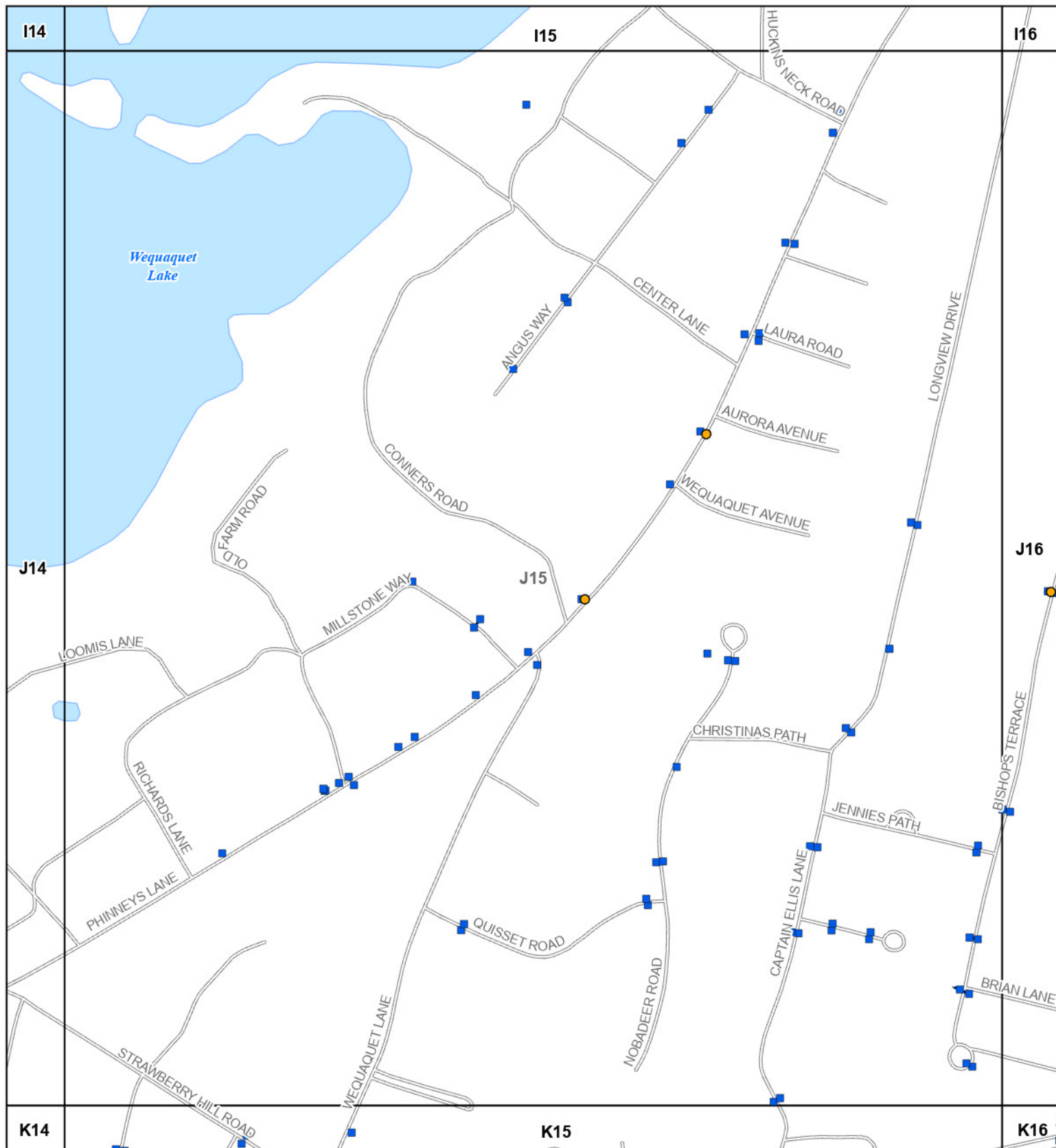
SHEET

J14

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Feet



Comprehensive
Environmental
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| ■ Catch Basin | ■ DOT Catch Basin |
| ● Drainage Manhole | — Storm Water Gravity Drain |
| ■ Stormwater BMP | — Swale |
| ★ Key Drainage Manhole | — Catchment |
| ✚ Interconnections | — Non-Urban Area |
| △ DOT Outfall | |

Stormwater Infrastructure Map Barnstable, MA

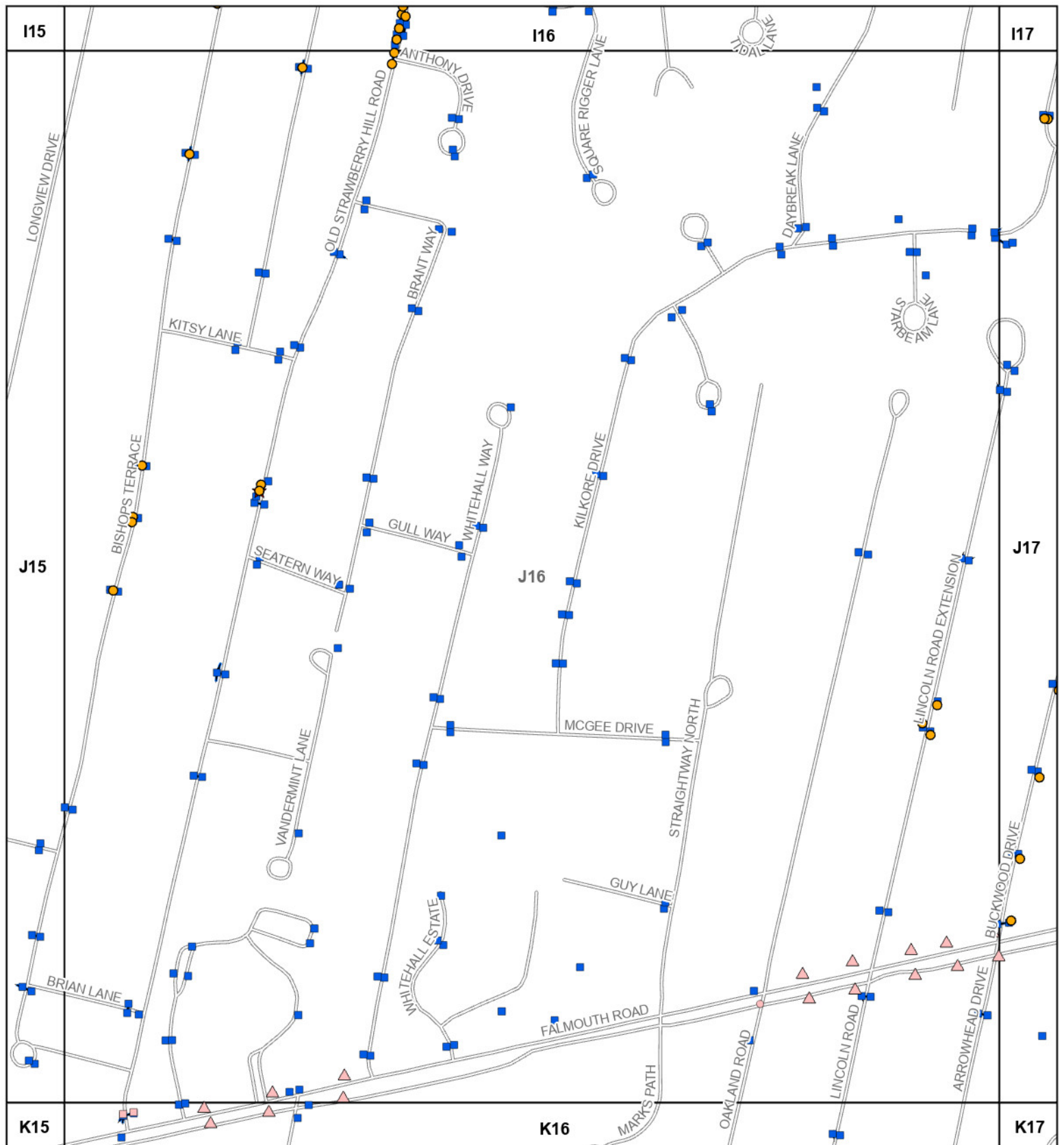
SHEET

J15

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Feet



Comprehensive
Environmental
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| ■ Catch Basin | ■ DOT Catch Basin |
| ● Drainage Manhole | — Storm Water Gravity Drain |
| ■ Stormwater BMP | — Swale |
| ★ Key Drainage Manhole | — Catchment |
| ✚ Interconnections | — Non-Urban Area |
| ▲ DOT Outfall | |

Stormwater Infrastructure Map Barnstable, MA

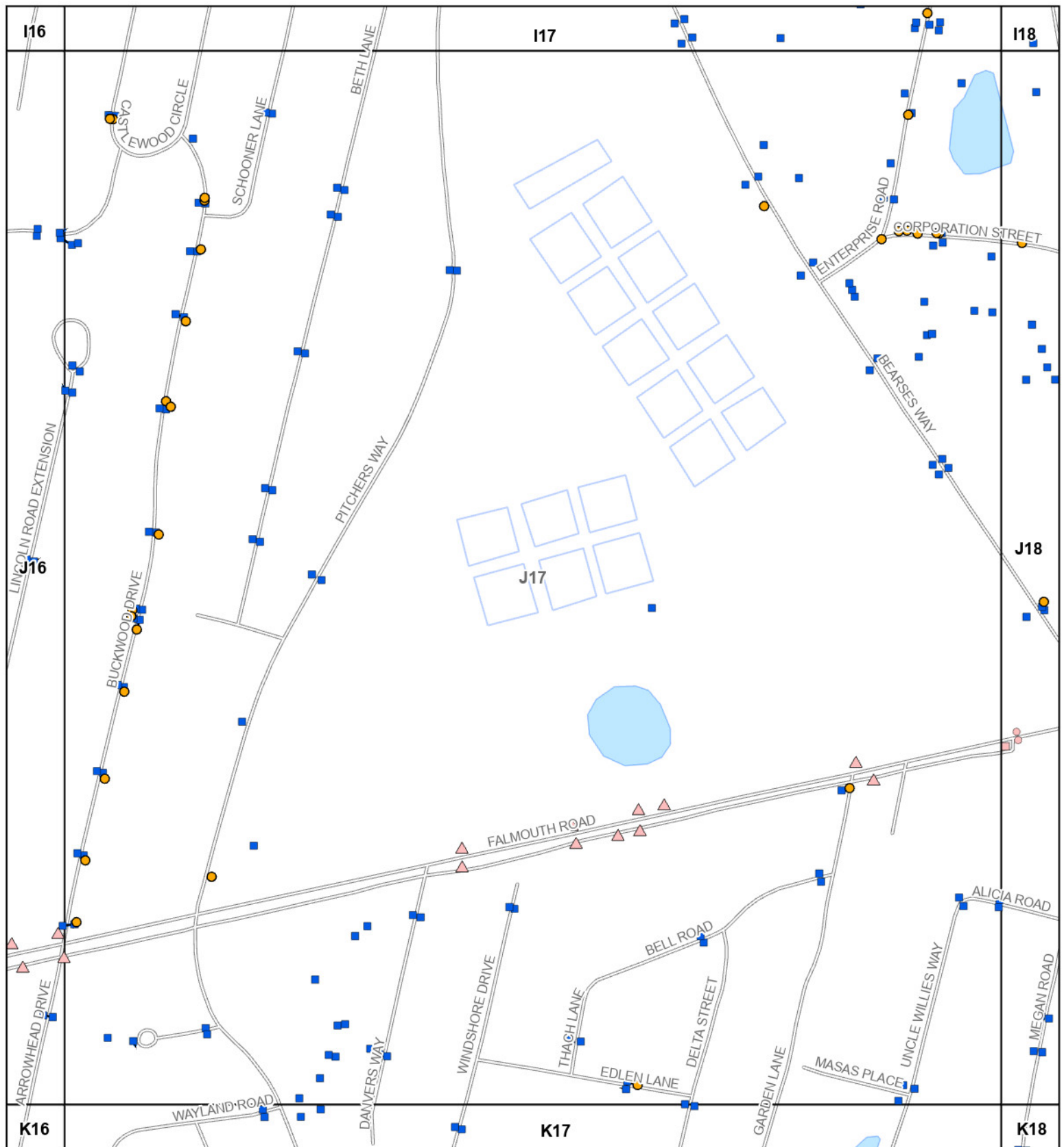
SHEET

J16

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Feet



Comprehensive
Environmental
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| ■ Catch Basin | ■ DOT Catch Basin |
| ● Drainage Manhole | — Storm Water Gravity Drain |
| ■ Stormwater BMP | — Swale |
| ★ Key Drainage Manhole | — Catchment |
| ✚ Interconnections | — Non-Urban Area |
| ▲ DOT Outfall | |

Stormwater Infrastructure Map Barnstable, MA

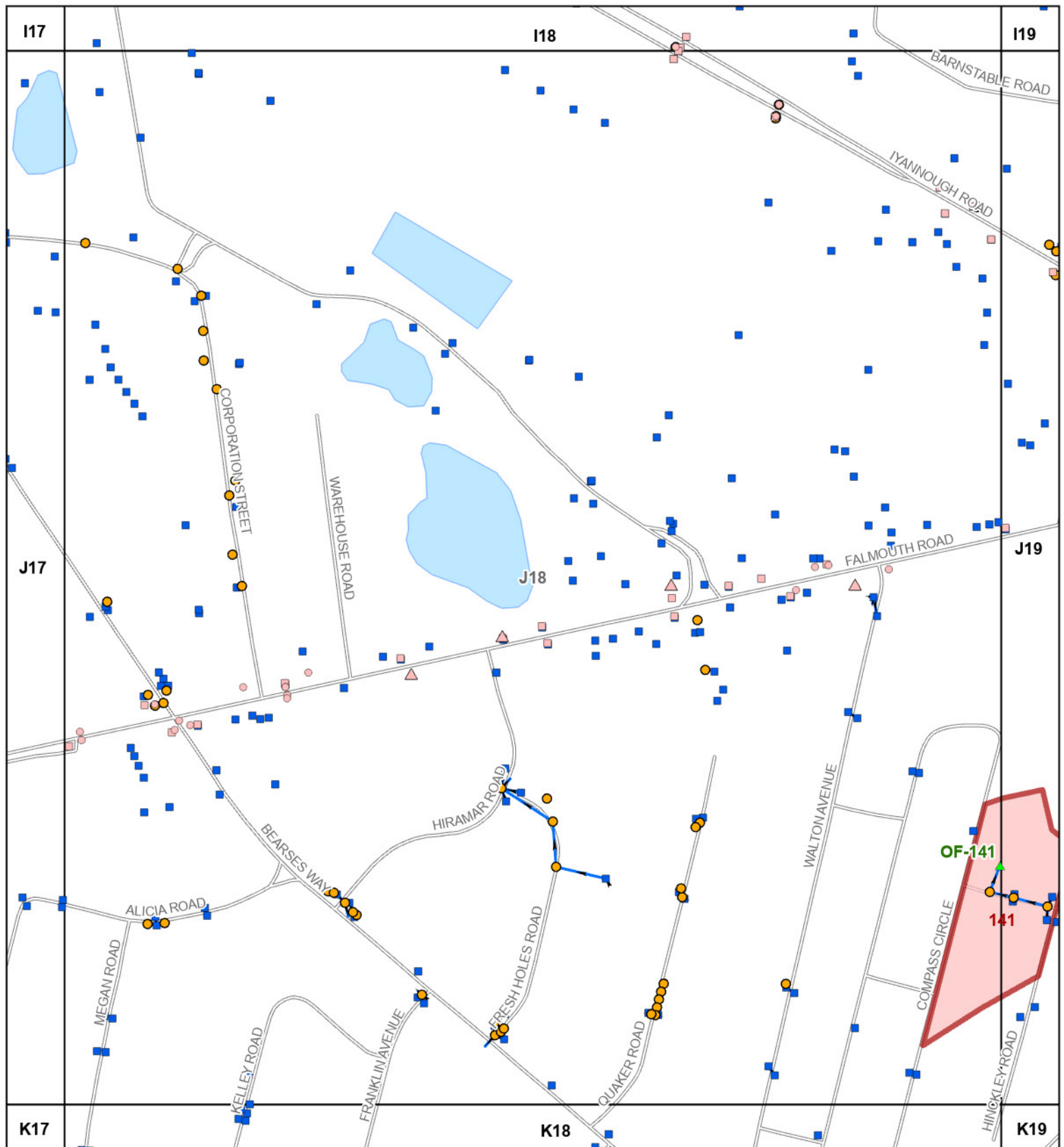
SHEET

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Feet



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| ▲ Outfalls | ● DOT Manhole |
| ■ Catch Basin | ■ DOT Catch Basin |
| ● Drainage Manhole | — Storm Water Gravity Drain |
| ■ Stormwater BMP | — Swale |
| ★ Key Drainage Manhole | — Catchment |
| ✚ Interconnections | — Non-Urban Area |
| ▲ DOT Outfall | |

Stormwater Infrastructure Map Barnstable, MA

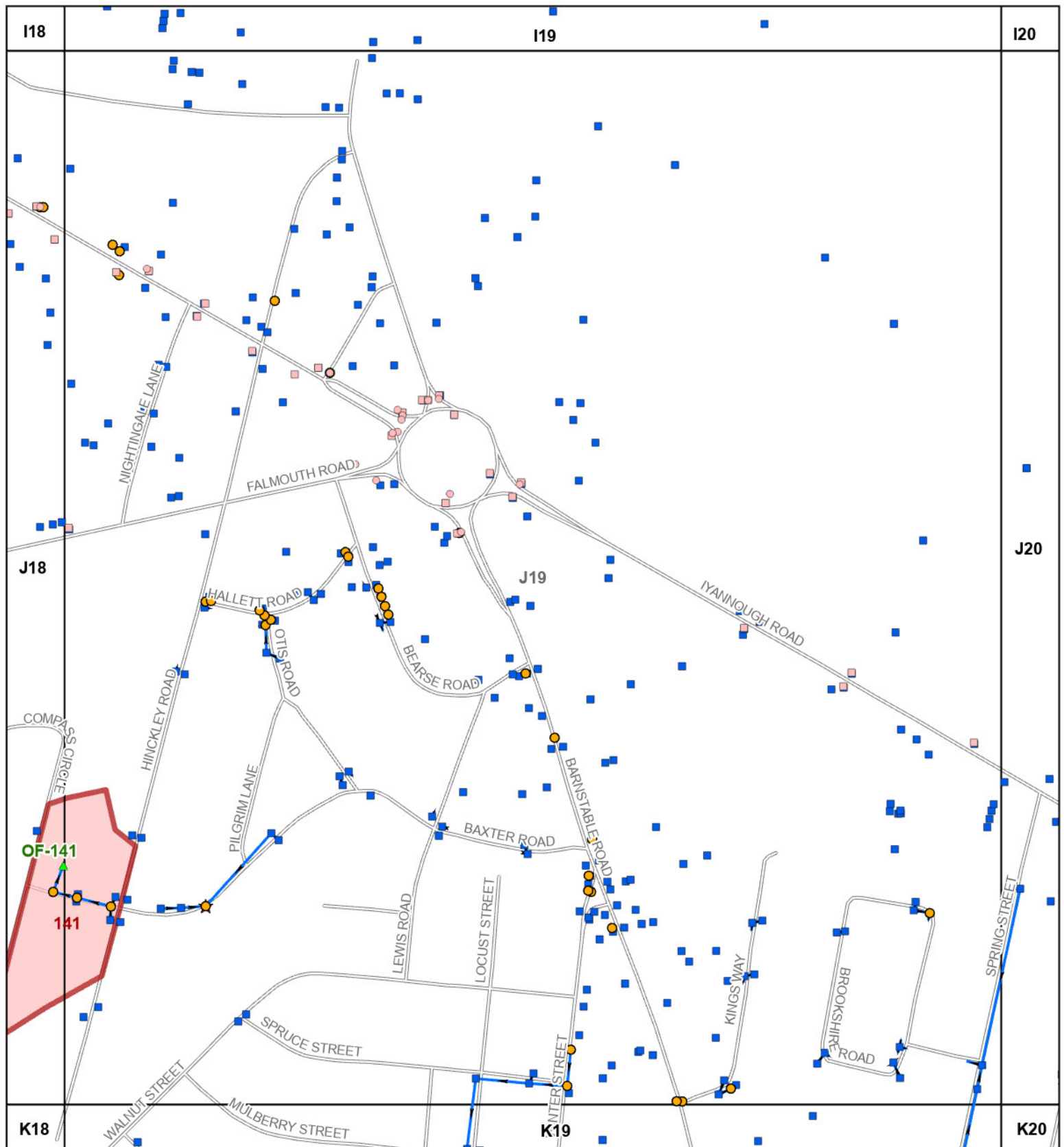
SHEET

J18

0 100 200 300 400 500
Feet



Comprehensive
Environmental
Incorporated



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| ▲ Outfalls | ● DOT Manhole |
| ■ Catch Basin | ■ DOT Catch Basin |
| ● Drainage Manhole | — Storm Water Gravity Drain |
| ■ Stormwater BMP | — Swale |
| ★ Key Drainage Manhole | — Catchment |
| ✚ Interconnections | — Non-Urban Area |
| ▲ DOT Outfall | |

Stormwater Infrastructure Map Barnstable, MA

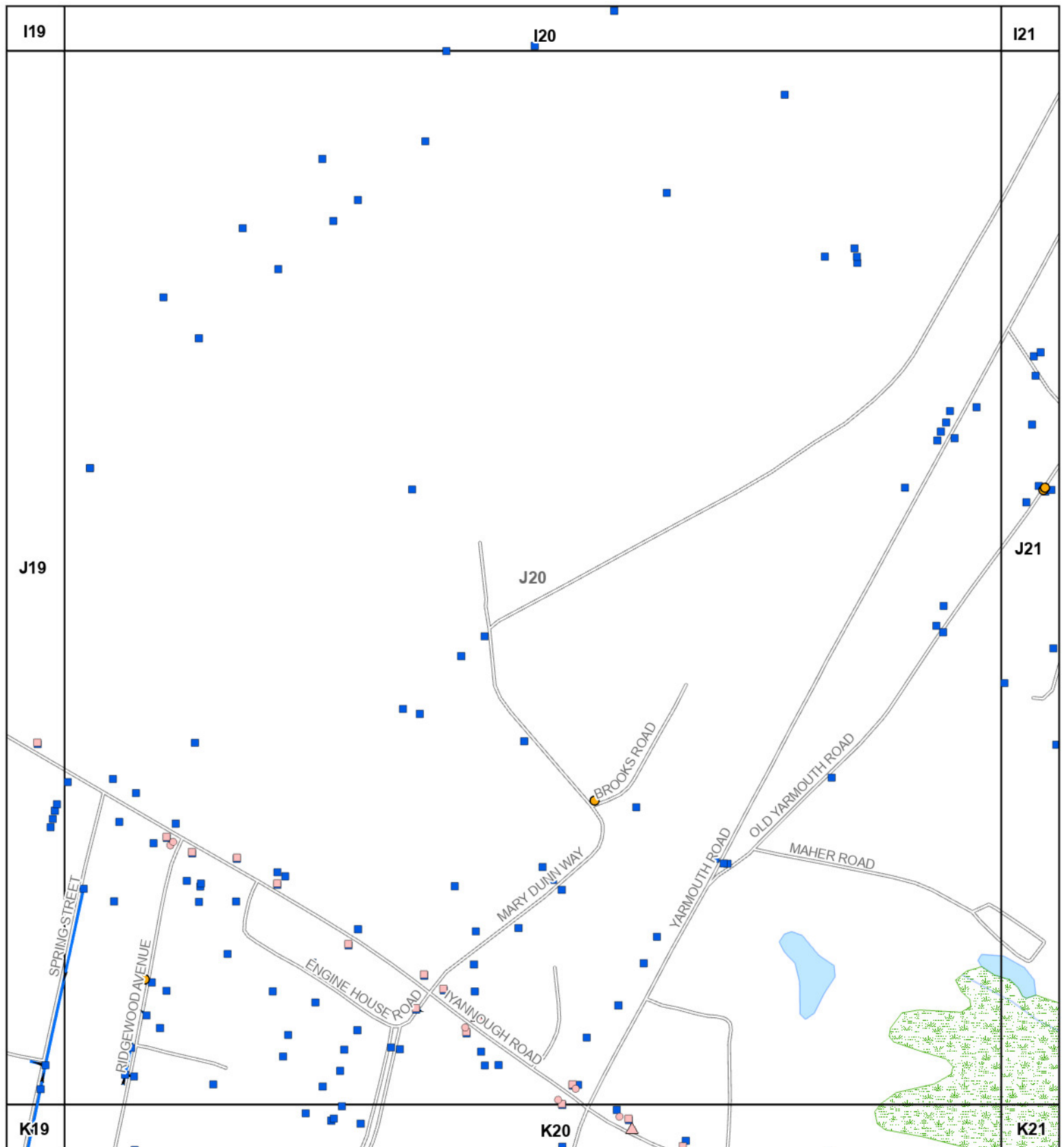
SHEET

J19

0 100 200 300 400 500
Feet



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| ▲ Outfalls | ○ DOT Manhole |
| ■ Catch Basin | ■ DOT Catch Basin |
| ● Drainage Manhole | — Storm Water Gravity Drain |
| ■ Stormwater BMP | — Swale |
| ★ Key Drainage Manhole | — Catchment |
| ✚ Interconnections | — Non-Urban Area |
| △ DOT Outfall | |

Stormwater Infrastructure Map Barnstable, MA

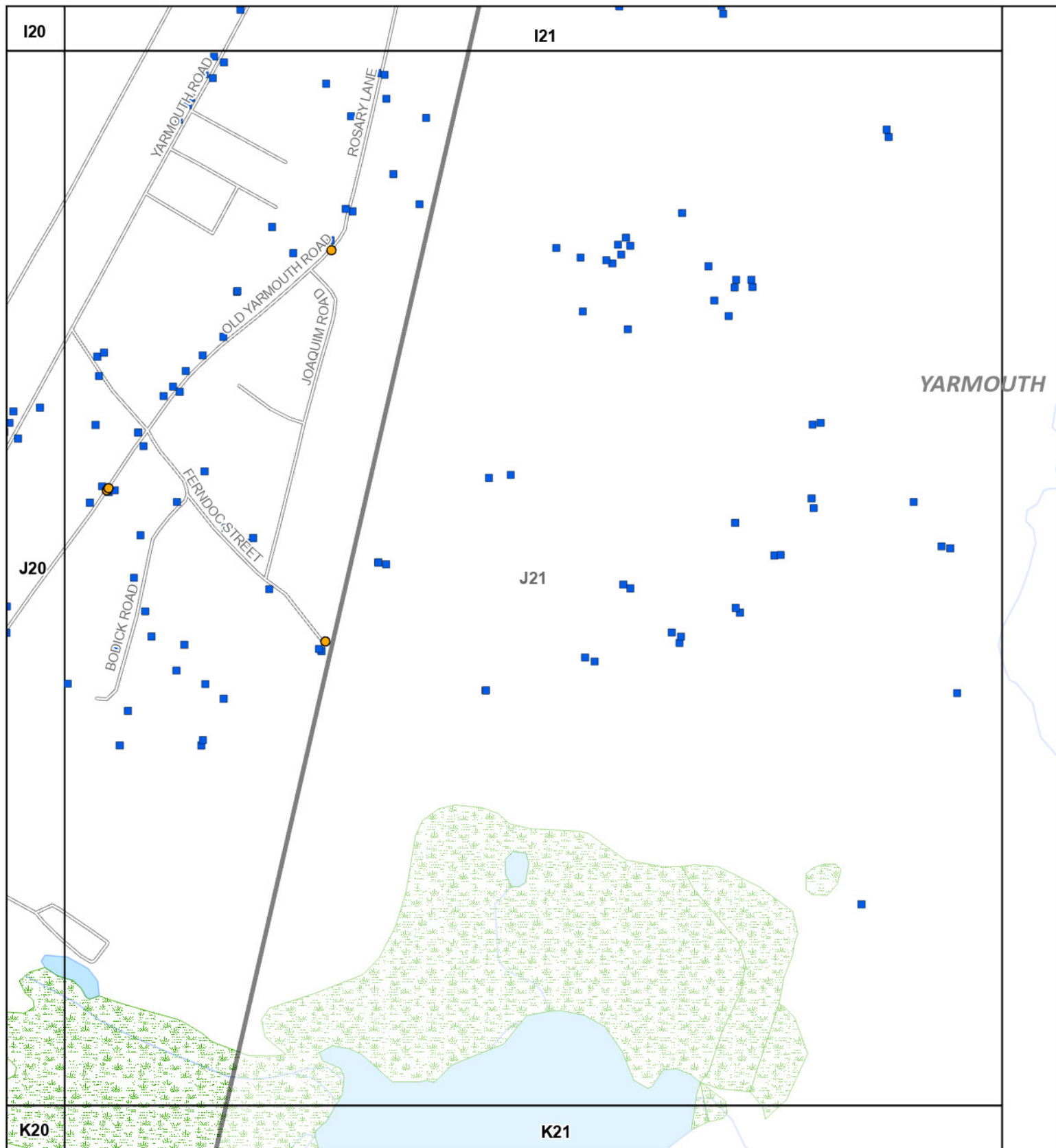
SHEET

J20

0 100 200 300 400 500
Feet



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Incorporated



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| ■ Catch Basin | ■ DOT Catch Basin |
| ● Drainage Manhole | — Storm Water Gravity Drain |
| ■ Stormwater BMP | — Swale |
| ★ Key Drainage Manhole | — Catchment |
| ✚ Interconnections | — Non-Urban Area |
| ▲ DOT Outfall | |

Stormwater Infrastructure Map Barnstable, MA

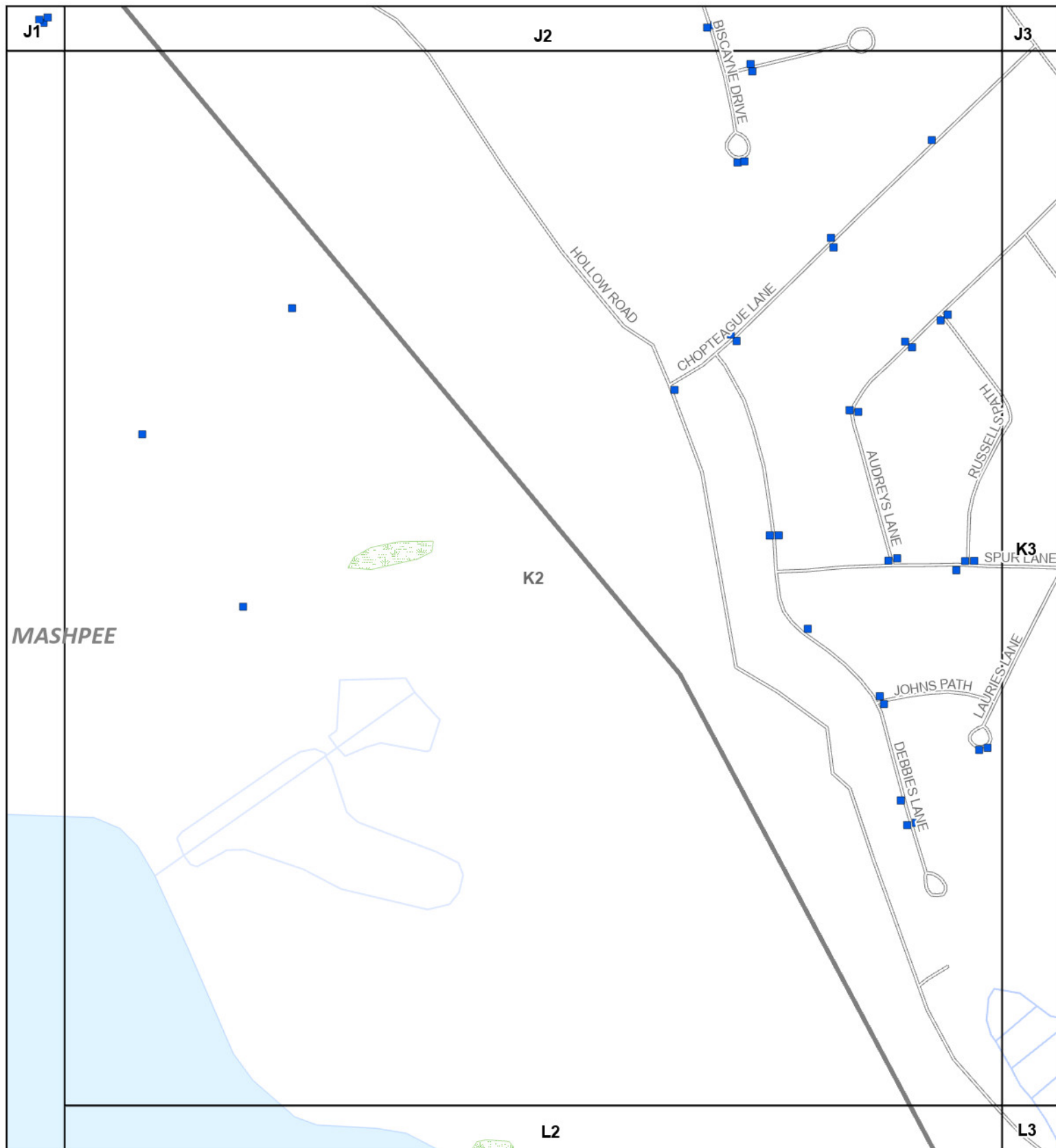
SHEET

J21

0 100 200 300 400 500
Feet



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Incorporated



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| ■ Catch Basin | ■ DOT Catch Basin |
| ● Drainage Manhole | — Storm Water Gravity Drain |
| ■ Stormwater BMP | — Swale |
| ★ Key Drainage Manhole | — Catchment |
| ✚ Interconnections | — Non-Urban Area |
| △ DOT Outfall | |

Stormwater Infrastructure Map Barnstable, MA

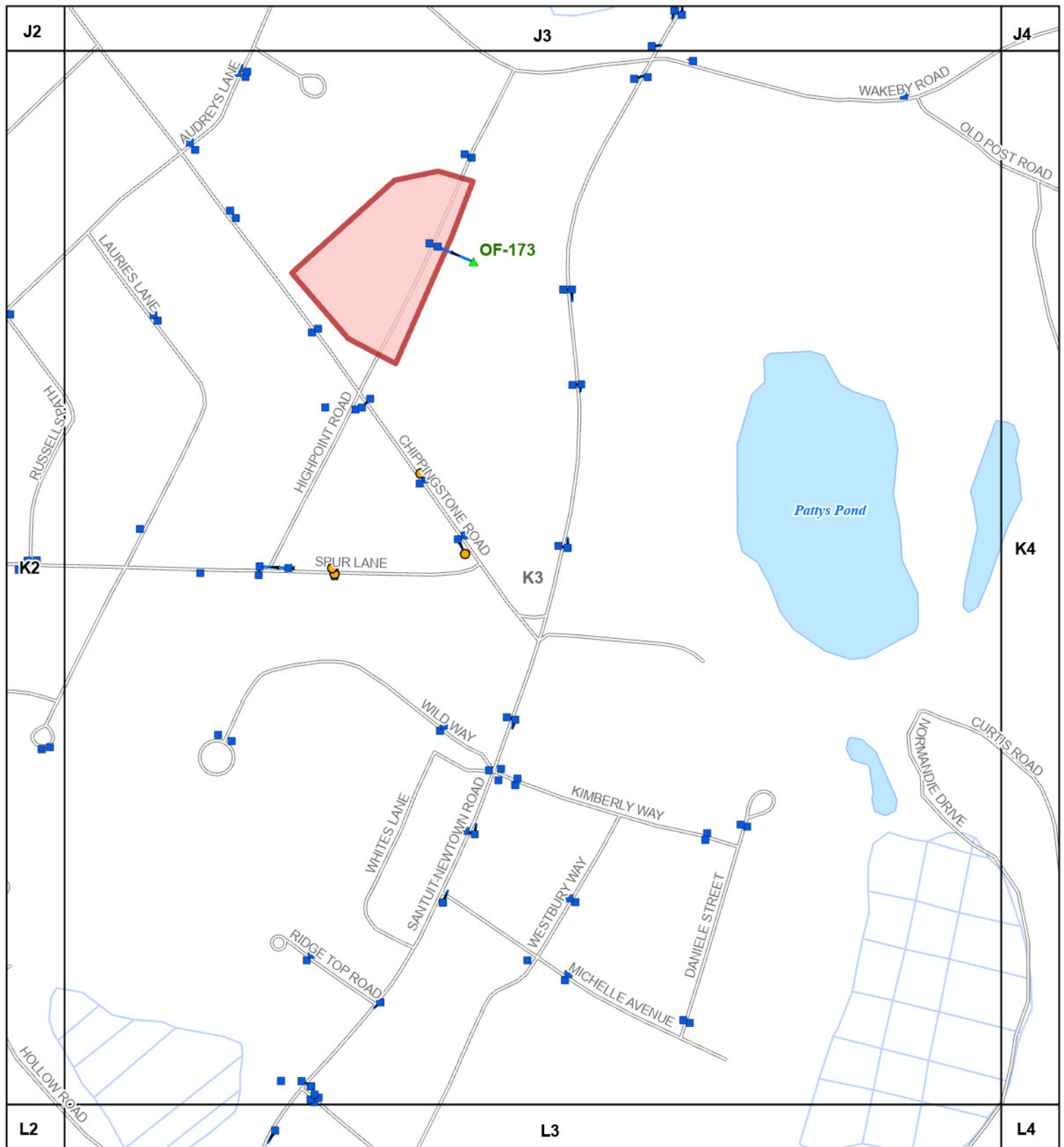
SHEET

K2

0 100 200 300 400 500
Feet



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Incorporated



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| ▲ Outfalls | ○ DOT Manhole |
| ■ Catch Basin | ■ DOT Catch Basin |
| ● Drainage Manhole | — Storm Water Gravity Drain |
| ■ Stormwater BMP | — Swale |
| ★ Key Drainage Manhole | — Catchment |
| ✚ Interconnections | — Non-Urban Area |
| ▲ DOT Outfall | |

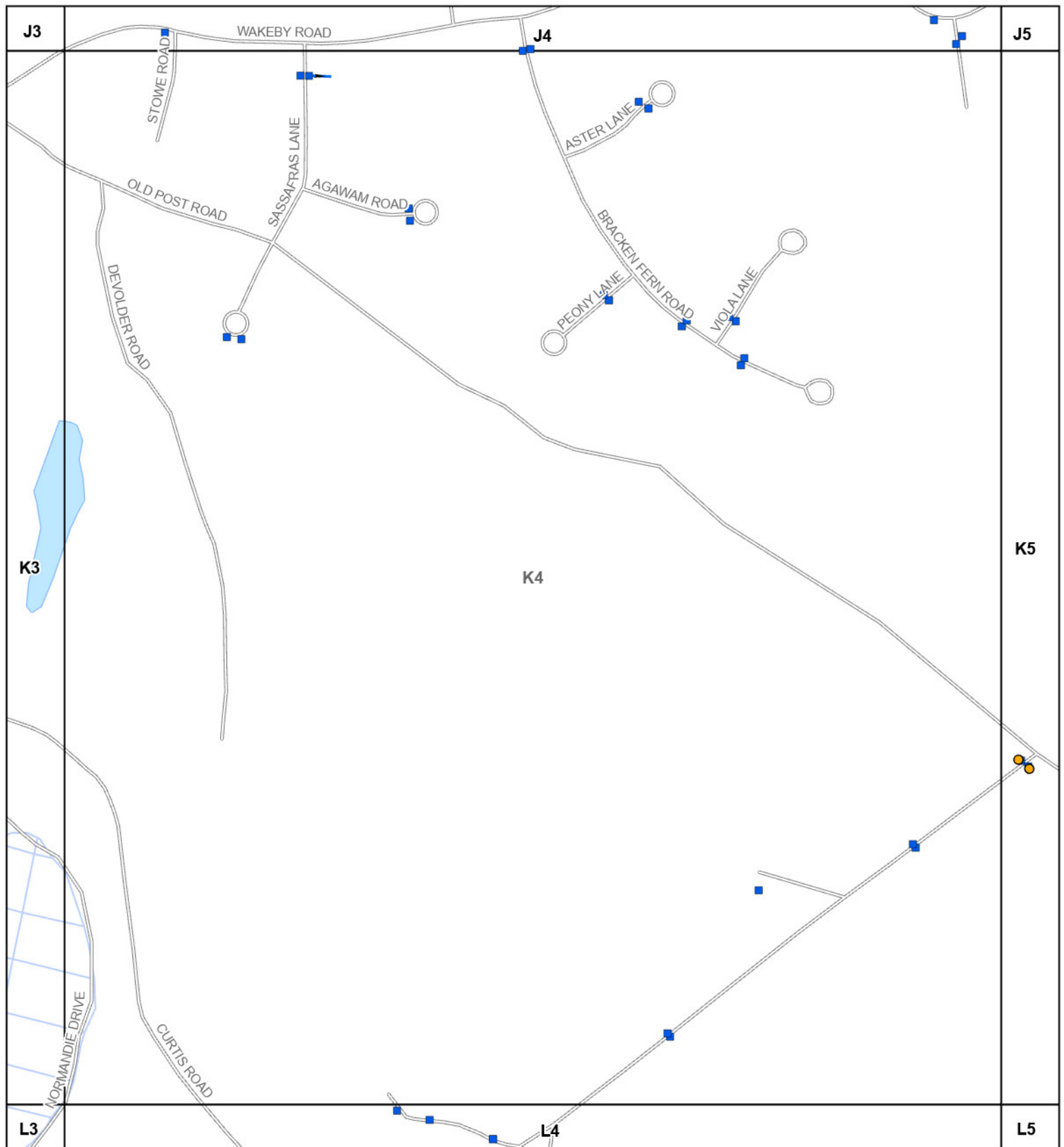
Stormwater Infrastructure Map Barnstable, MA

SHEET
K3

0 100 200 300 400 500
Feet



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Environmental
Incorporated



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| ▲ Outfalls | ○ DOT Manhole |
| ■ Catch Basin | ■ DOT Catch Basin |
| ● Drainage Manhole | — Storm Water Gravity Drain |
| ■ Stormwater BMP | — Swale |
| ★ Key Drainage Manhole | — Catchment |
| ✚ Interconnections | — Non-Urban Area |
| △ DOT Outfall | |

Stormwater Infrastructure Map Barnstable, MA

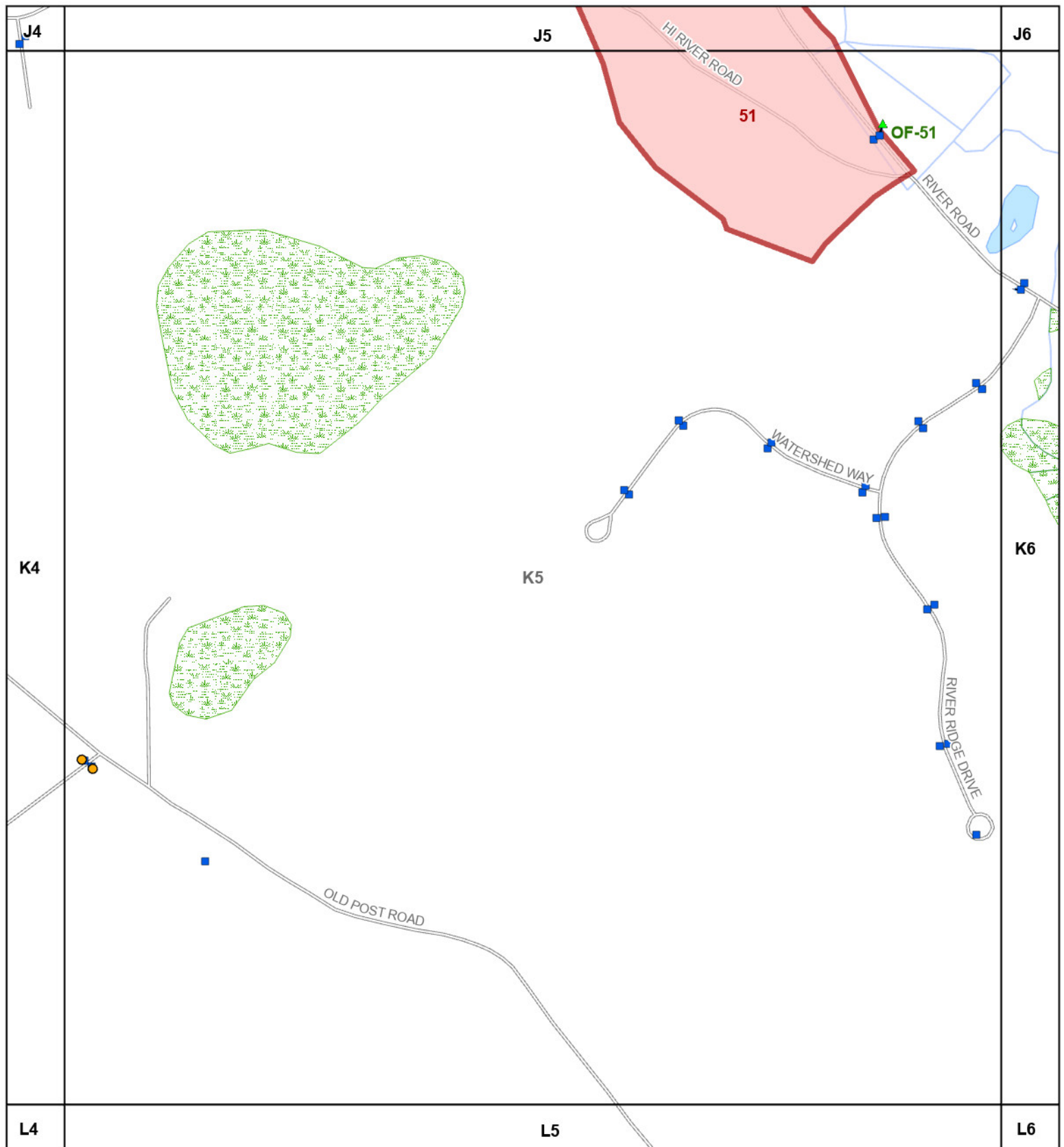
SHEET

K4

0 100 200 300 400 500
Feet



Comprehensive
Environmental
Incorporated



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| ▲ Outfalls | ○ DOT Manhole |
| ■ Catch Basin | ■ DOT Catch Basin |
| ● Drainage Manhole | — Storm Water Gravity Drain |
| ■ Stormwater BMP | — Swale |
| ★ Key Drainage Manhole | — Catchment |
| ✚ Interconnections | — Non-Urban Area |
| △ DOT Outfall | |

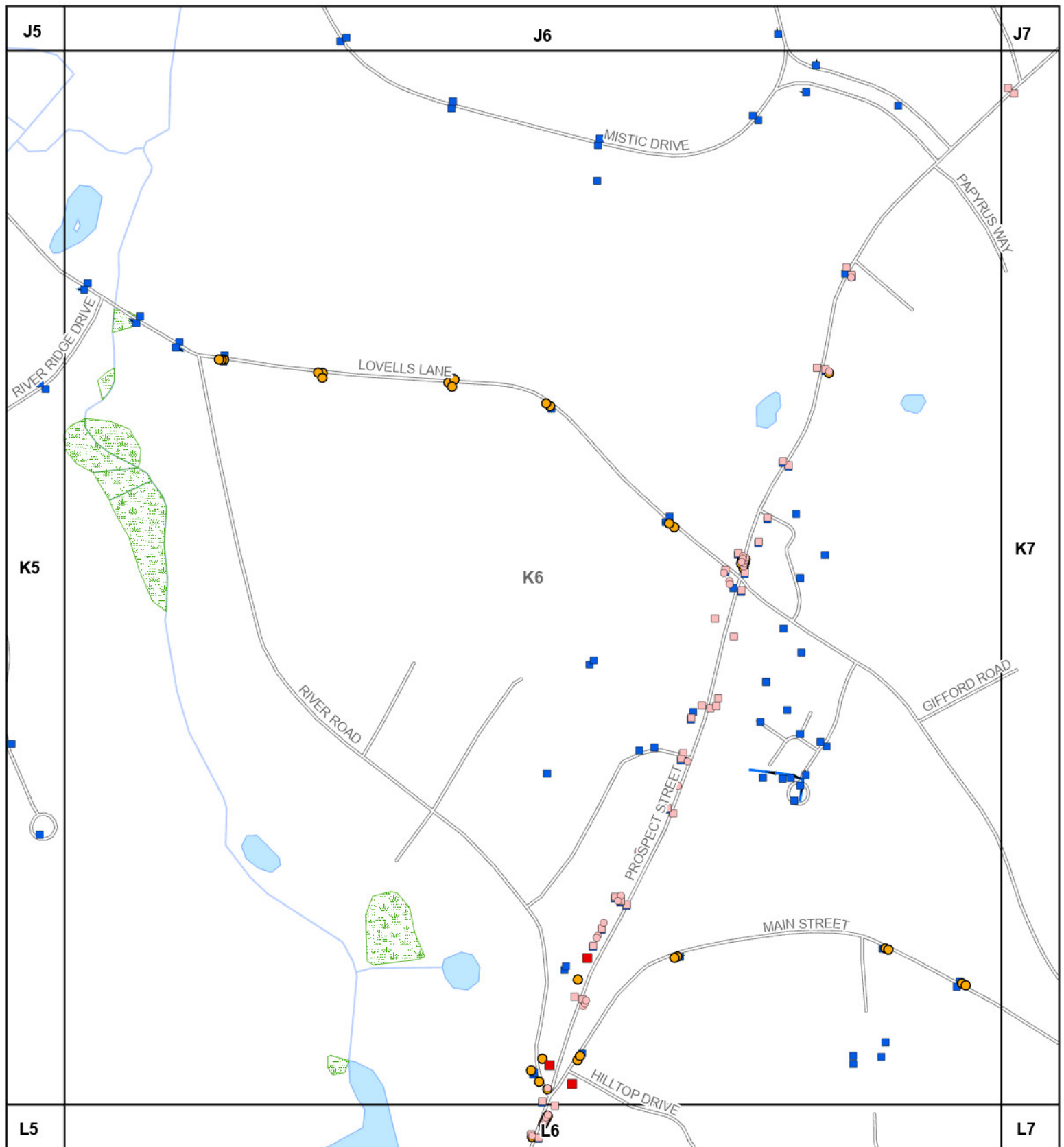
Stormwater Infrastructure Map Barnstable, MA

SHEET
K5

0 100 200 300 400 500
Feet



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Environmental
Incorporated



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| ▲ Outfalls | ● DOT Manhole |
| ■ Catch Basin | ■ DOT Catch Basin |
| ● Drainage Manhole | — Storm Water Gravity Drain |
| ■ Stormwater BMP | — Swale |
| ★ Key Drainage Manhole | — Catchment |
| ✚ Interconnections | — Non-Urban Area |
| ▲ DOT Outfall | |

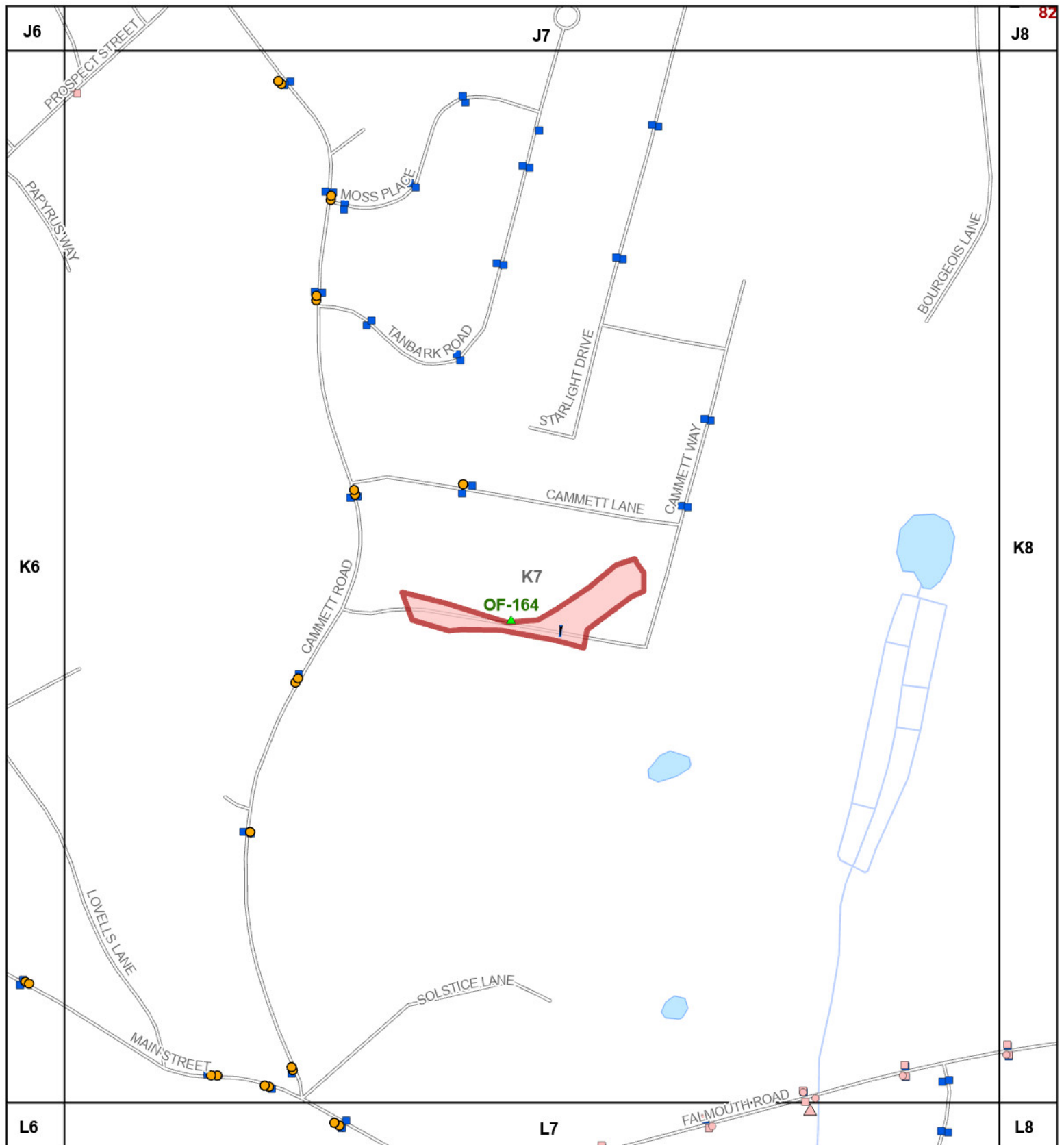
Stormwater Infrastructure Map Barnstable, MA

SHEET
K6

0 100 200 300 400 500
Feet



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Incorporated



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| ▲ Outfalls | ● DOT Manhole |
| ■ Catch Basin | ■ DOT Catch Basin |
| ● Drainage Manhole | — Storm Water Gravity Drain |
| ■ Stormwater BMP | — Swale |
| ★ Key Drainage Manhole | — Catchment |
| ✚ Interconnections | — Non-Urban Area |
| ▲ DOT Outfall | |

Stormwater Infrastructure Map Barnstable, MA

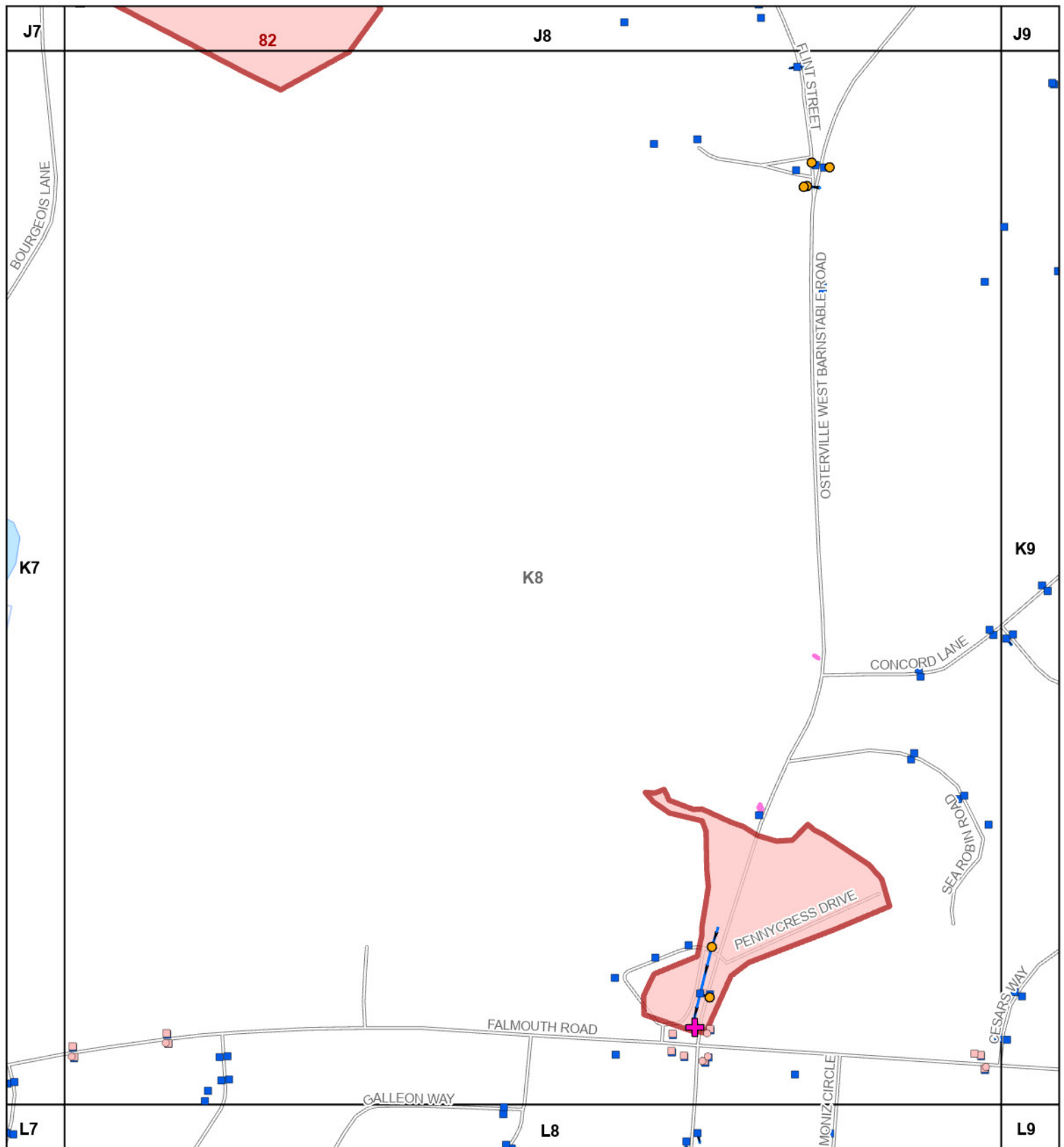
SHEET

K7

0 100 200 300 400 500
Feet



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Environmental
Incorporated



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| ▲ Outfalls | ○ DOT Manhole |
| ■ Catch Basin | ■ DOT Catch Basin |
| ● Drainage Manhole | — Storm Water Gravity Drain |
| ■ Stormwater BMP | — Swale |
| ★ Key Drainage Manhole | — Catchment |
| ✚ Interconnections | — Non-Urban Area |
| △ DOT Outfall | |

Stormwater Infrastructure Map Barnstable, MA

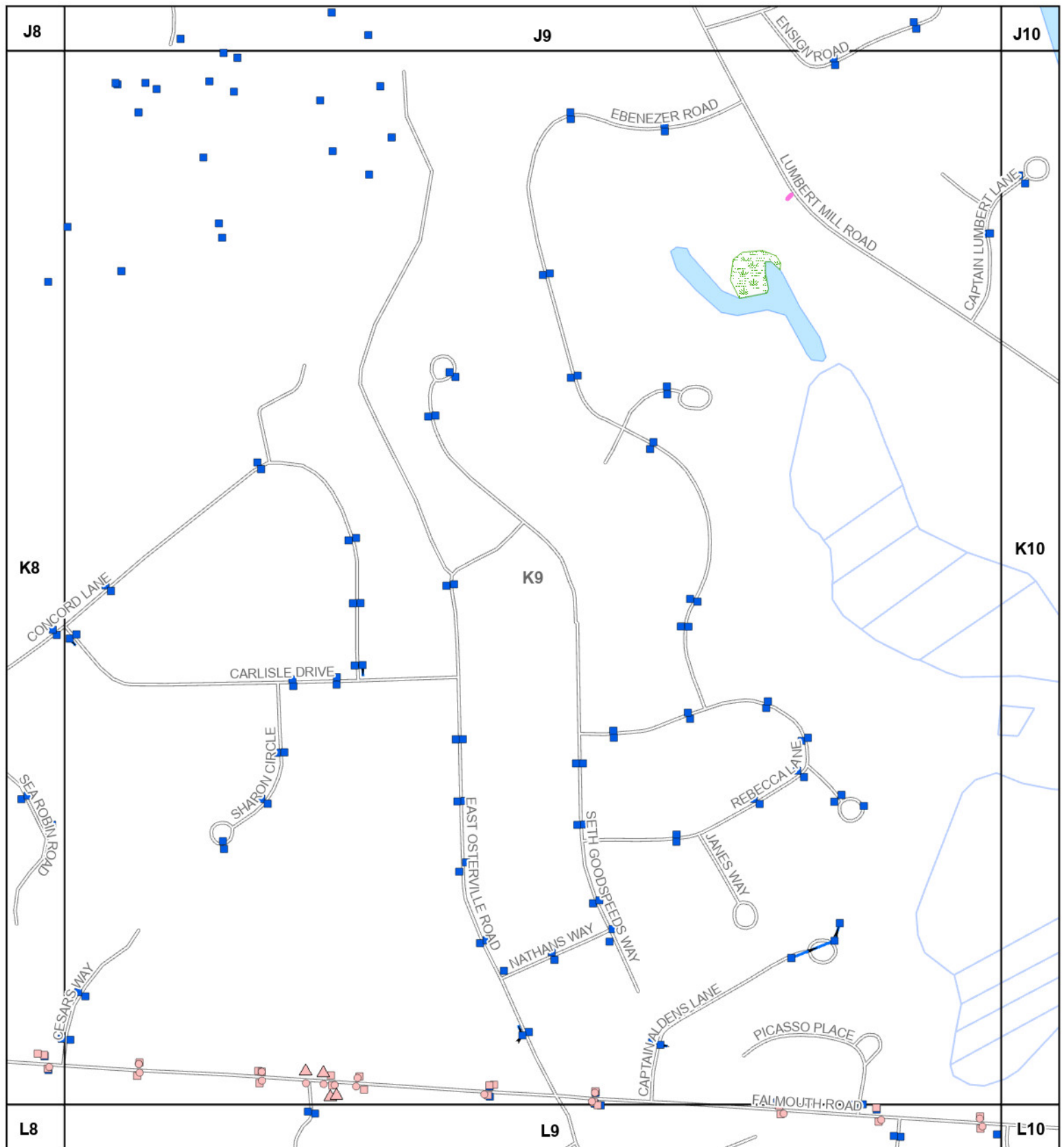
SHEET

K8

0 100 200 300 400 500
Feet



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Environmental
Incorporated



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| ▲ Outfalls | ● DOT Manhole |
| ■ Catch Basin | ■ DOT Catch Basin |
| ● Drainage Manhole | — Storm Water Gravity Drain |
| ■ Stormwater BMP | — Swale |
| ★ Key Drainage Manhole | — Catchment |
| ✚ Interconnections | — Non-Urban Area |
| ▲ DOT Outfall | |

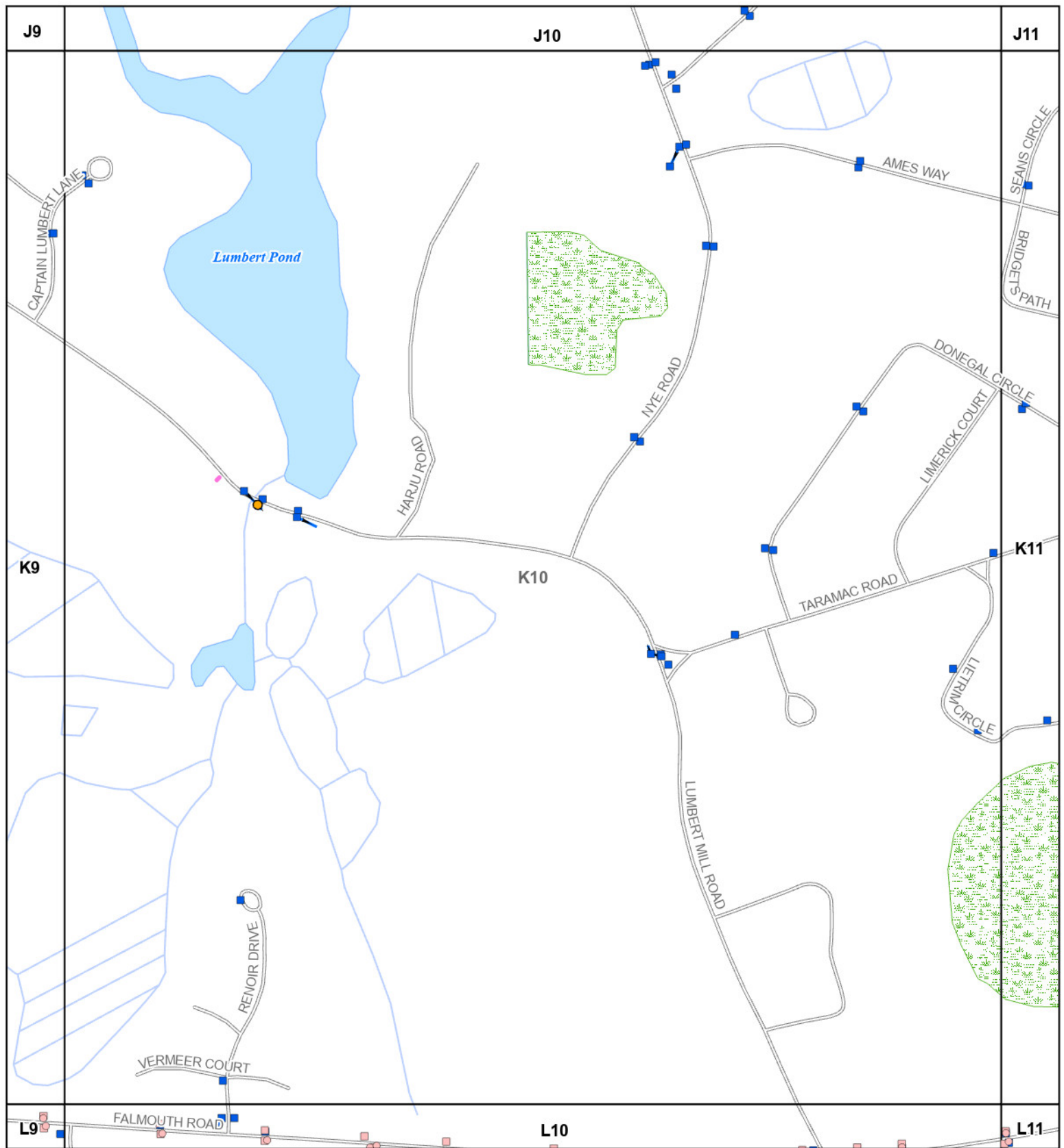
Stormwater Infrastructure Map Barnstable, MA

SHEET
K9

0 100 200 300 400 500
Feet



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Environmental
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| ▲ Outfalls | ● DOT Manhole |
| ■ Catch Basin | ■ DOT Catch Basin |
| ● Drainage Manhole | — Storm Water Gravity Drain |
| ■ Stormwater BMP | — Swale |
| ★ Key Drainage Manhole | — Catchment |
| ✚ Interconnections | — Non-Urban Area |
| ▲ DOT Outfall | |

Stormwater Infrastructure Map Barnstable, MA

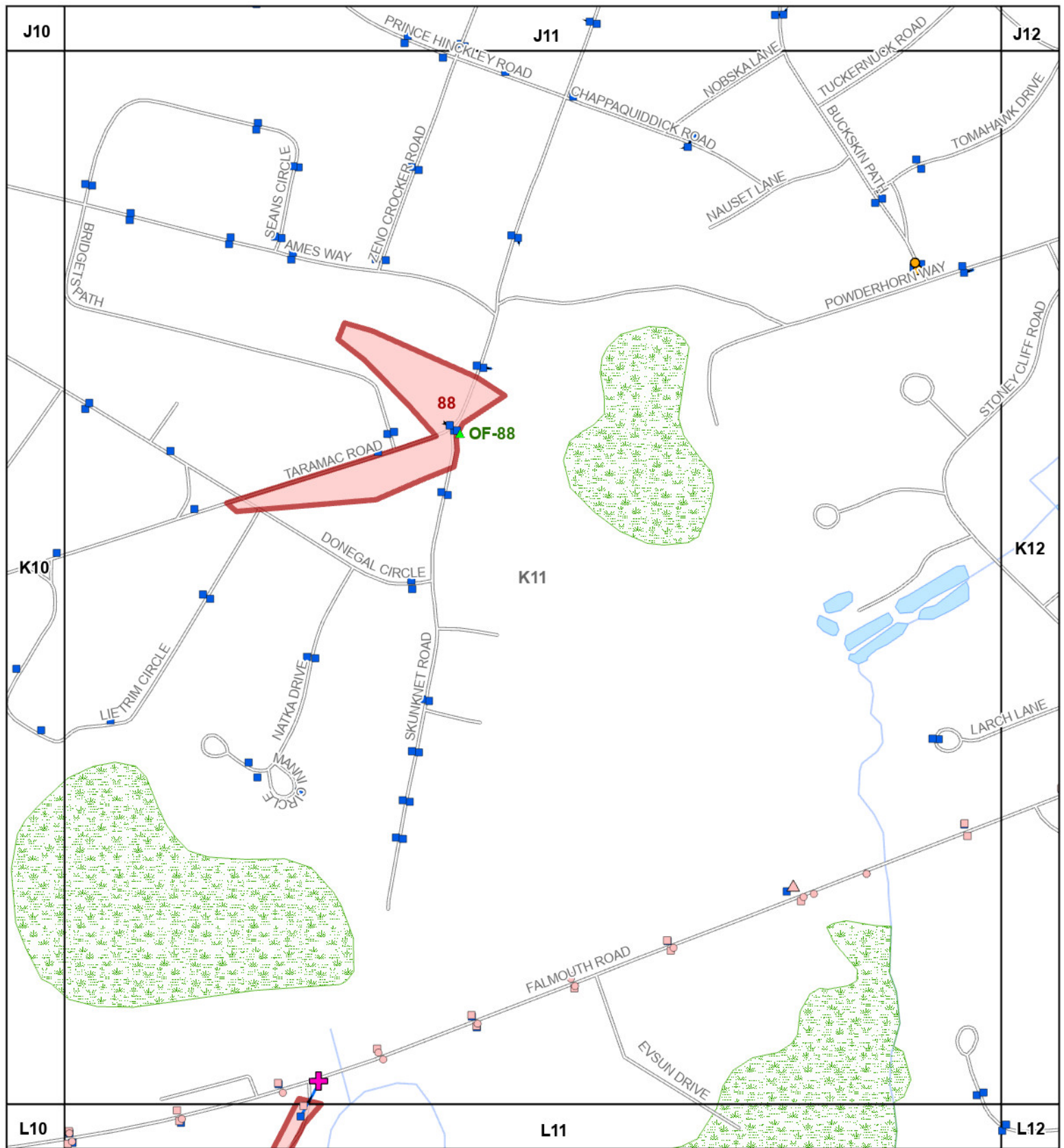
SHEET

K10

0 100 200 300 400 500
Feet



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| ▲ Outfalls | ● DOT Manhole |
| ■ Catch Basin | ■ DOT Catch Basin |
| ● Drainage Manhole | — Storm Water Gravity Drain |
| ■ Stormwater BMP | — Swale |
| ★ Key Drainage Manhole | — Catchment |
| ✚ Interconnections | — Non-Urban Area |
| ▲ DOT Outfall | |

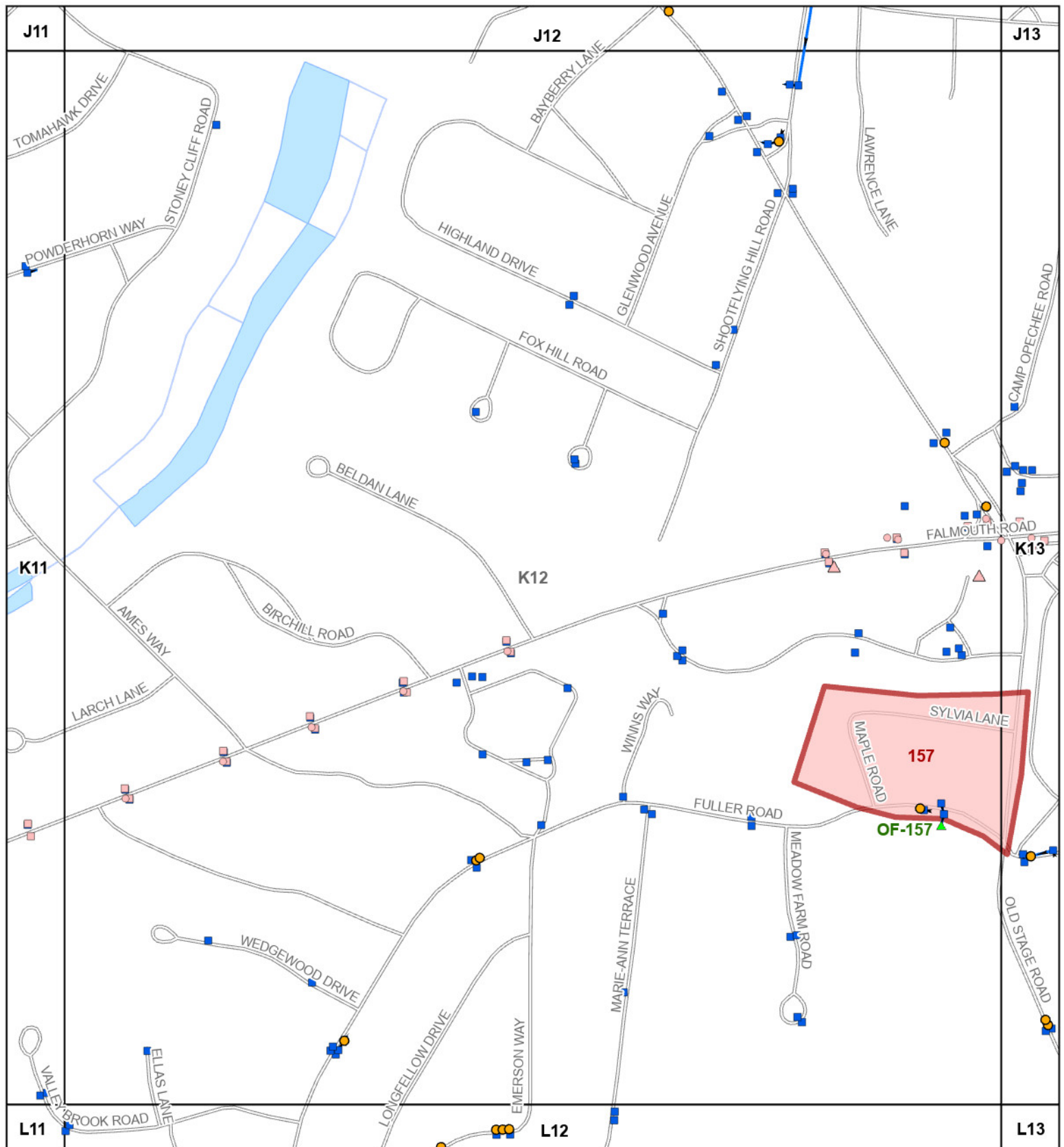
Stormwater Infrastructure Map Barnstable, MA

SHEET
K11

0 100 200 300 400 500
Feet



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| ▲ Outfalls | ● DOT Manhole |
| ■ Catch Basin | ■ DOT Catch Basin |
| ● Drainage Manhole | — Storm Water Gravity Drain |
| ■ Stormwater BMP | — Swale |
| ★ Key Drainage Manhole | — Catchment |
| ✚ Interconnections | — Non-Urban Area |
| ▲ DOT Outfall | |

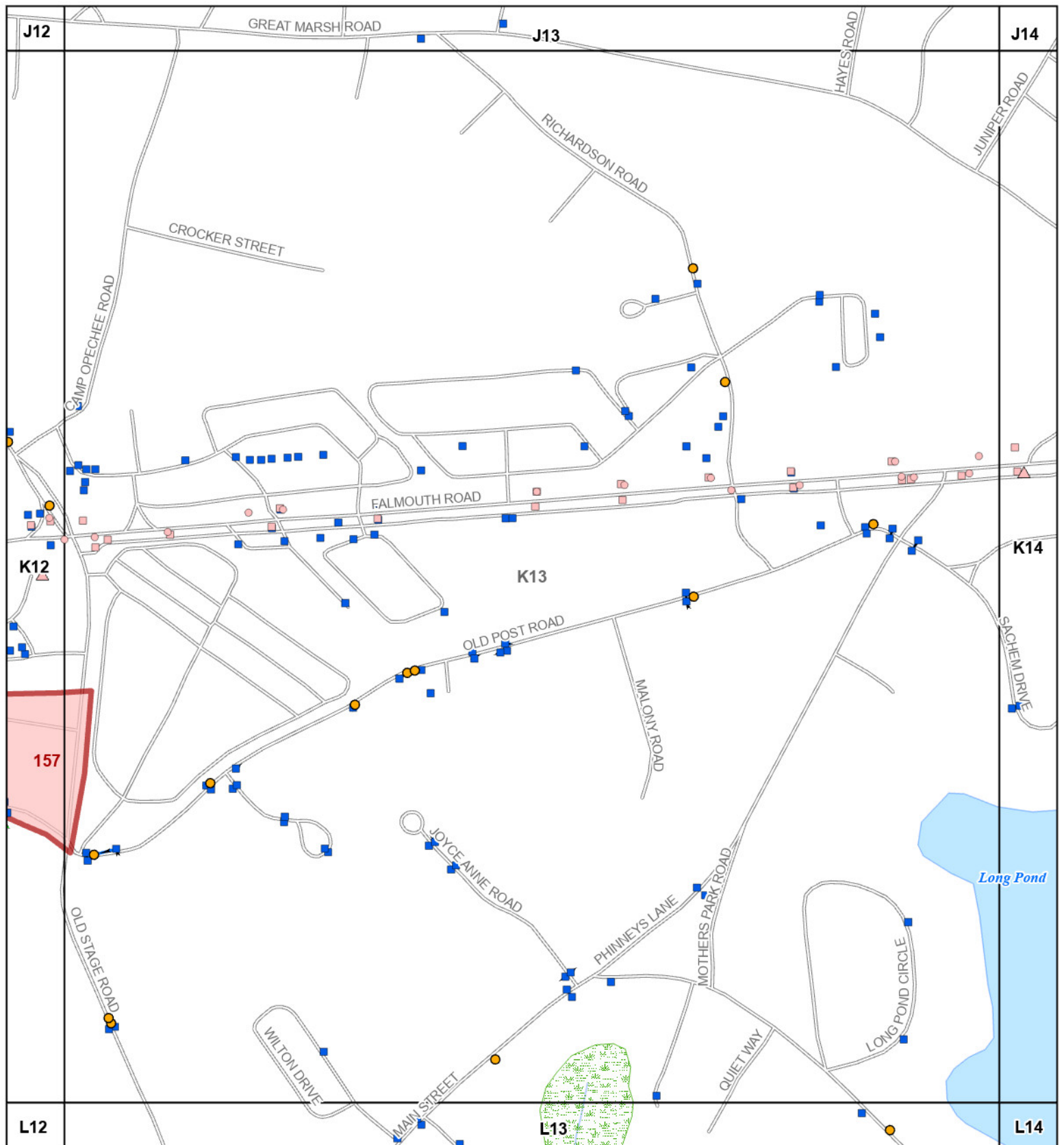
Stormwater Infrastructure Map Barnstable, MA

SHEET
K12

0 100 200 300 400 500
Feet



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| ▲ Outfalls | ● DOT Manhole |
| ■ Catch Basin | ■ DOT Catch Basin |
| ● Drainage Manhole | — Storm Water Gravity Drain |
| ■ Stormwater BMP | — Swale |
| ★ Key Drainage Manhole | — Catchment |
| ✚ Interconnections | — Non-Urban Area |
| ▲ DOT Outfall | |

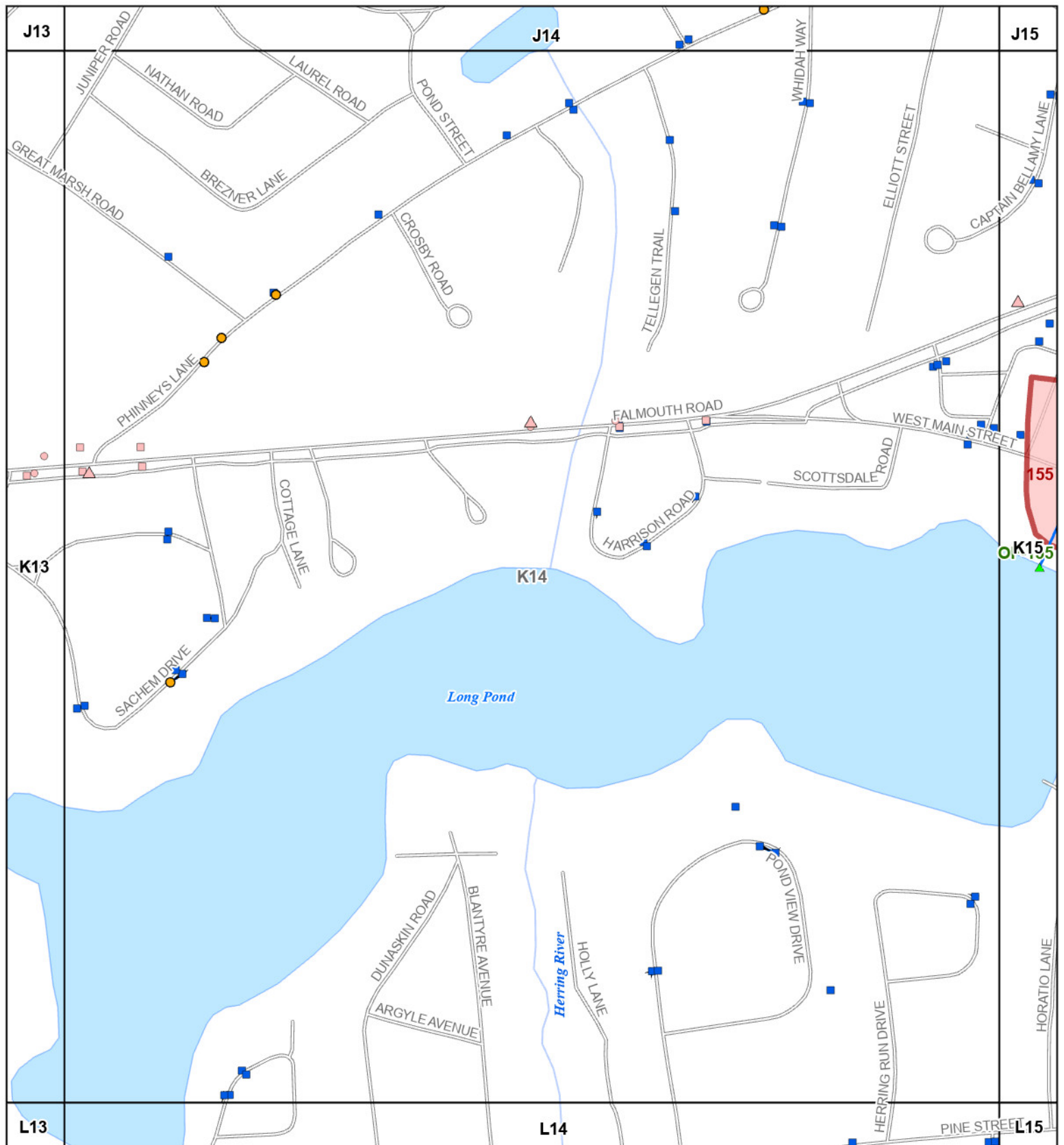
Stormwater Infrastructure Map Barnstable, MA

SHEET
K13

0 100 200 300 400 500
Feet



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| ▲ Outfalls | ● DOT Manhole |
| ■ Catch Basin | ■ DOT Catch Basin |
| ● Drainage Manhole | — Storm Water Gravity Drain |
| ■ Stormwater BMP | — Swale |
| ★ Key Drainage Manhole | — Catchment |
| ✚ Interconnections | — Non-Urban Area |
| ▲ DOT Outfall | |

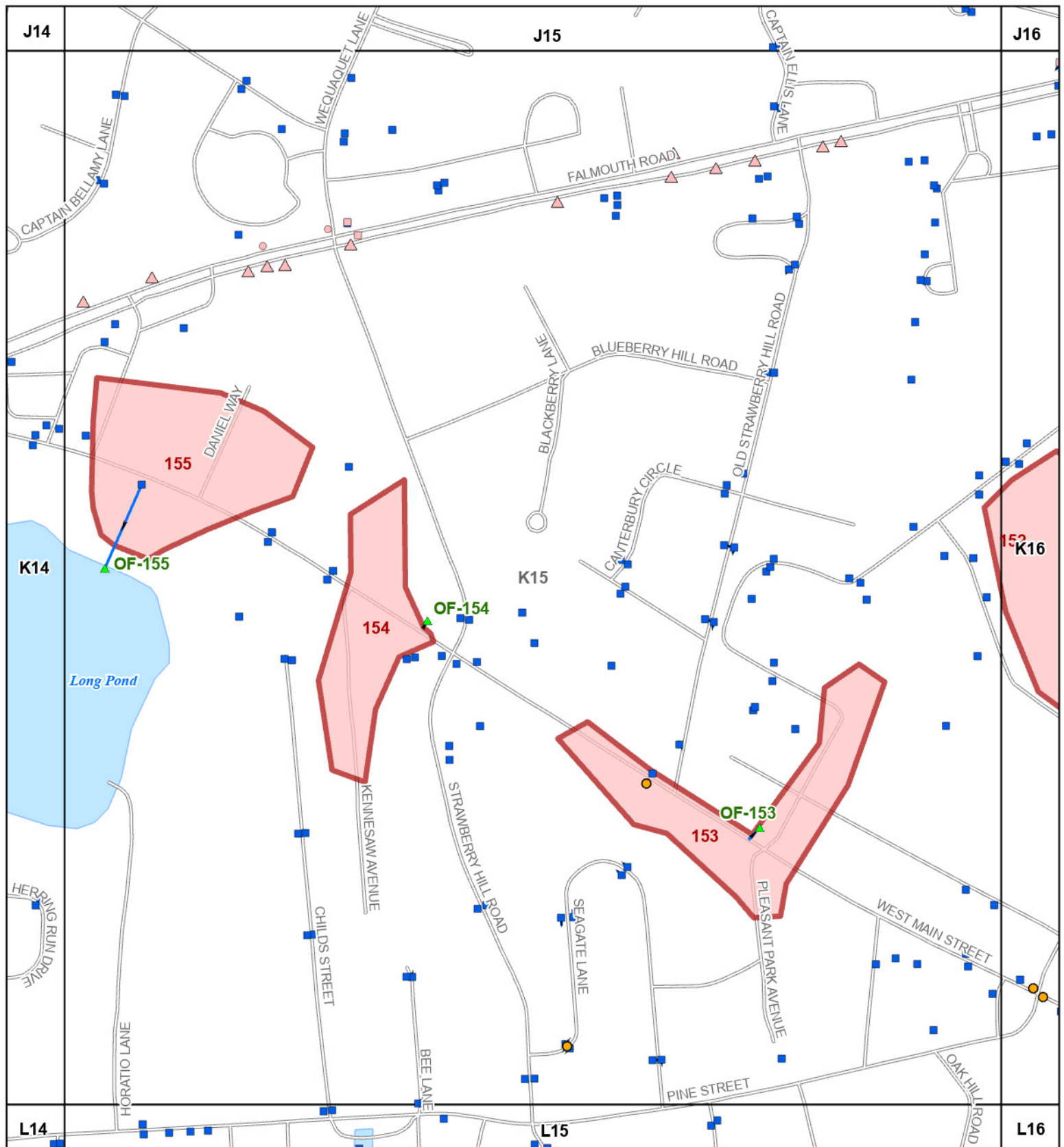
Stormwater Infrastructure Map Barnstable, MA

SHEET
K14

0 100 200 300 400 500
Feet



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| ▲ Outfalls | ● DOT Manhole |
| ■ Catch Basin | ■ DOT Catch Basin |
| ● Drainage Manhole | — Storm Water Gravity Drain |
| ■ Stormwater BMP | — Swale |
| ★ Key Drainage Manhole | — Catchment |
| ✚ Interconnections | — Non-Urban Area |
| ▲ DOT Outfall | |

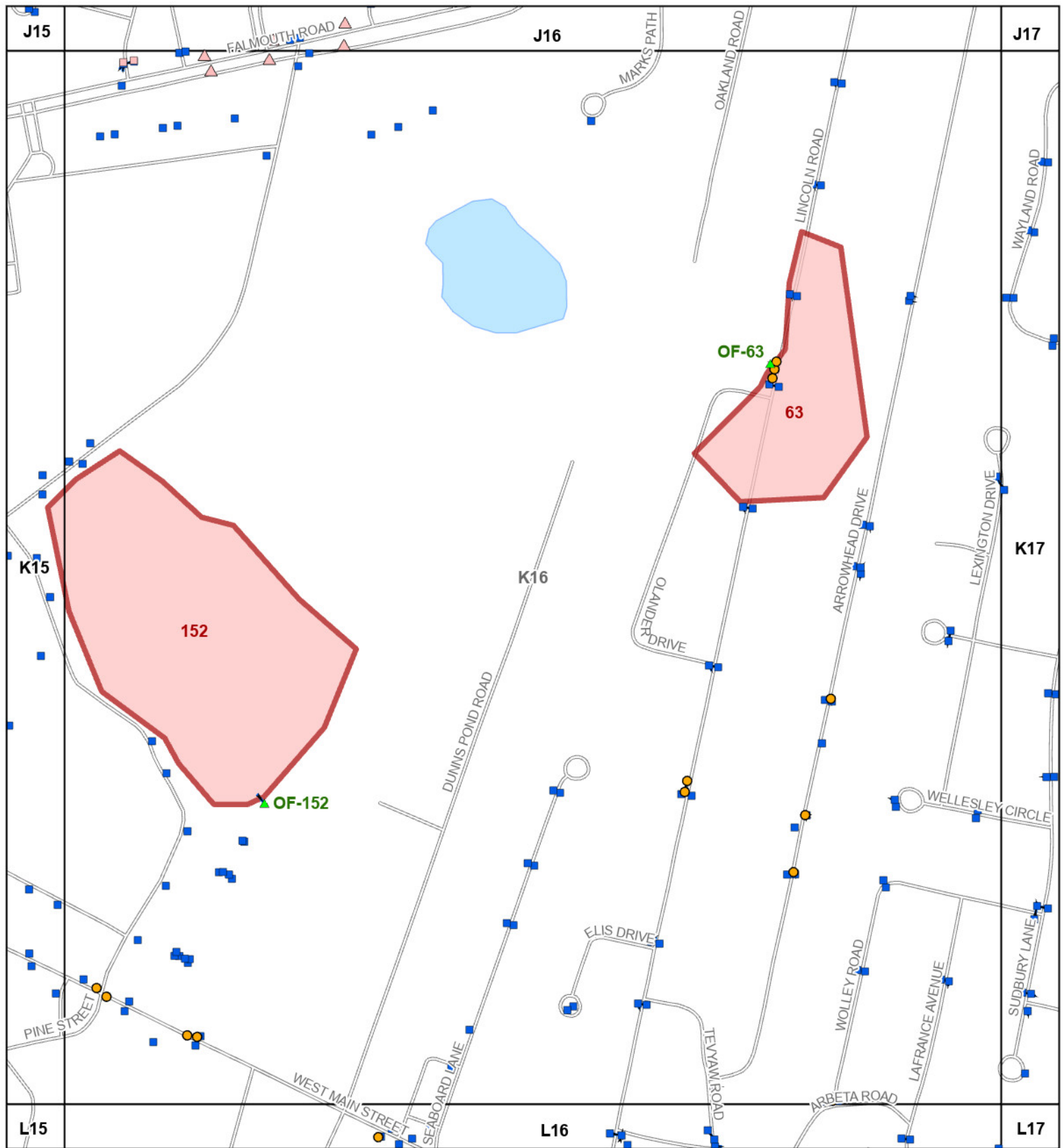
Stormwater Infrastructure Map Barnstable, MA

SHEET
K15

0 100 200 300 400 500
Feet



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| ▲ Outfalls | ○ DOT Manhole |
| ■ Catch Basin | ■ DOT Catch Basin |
| ● Drainage Manhole | — Storm Water Gravity Drain |
| ■ Stormwater BMP | — Swale |
| ★ Key Drainage Manhole | — Catchment |
| ✚ Interconnections | — Non-Urban Area |
| ▲ DOT Outfall | |

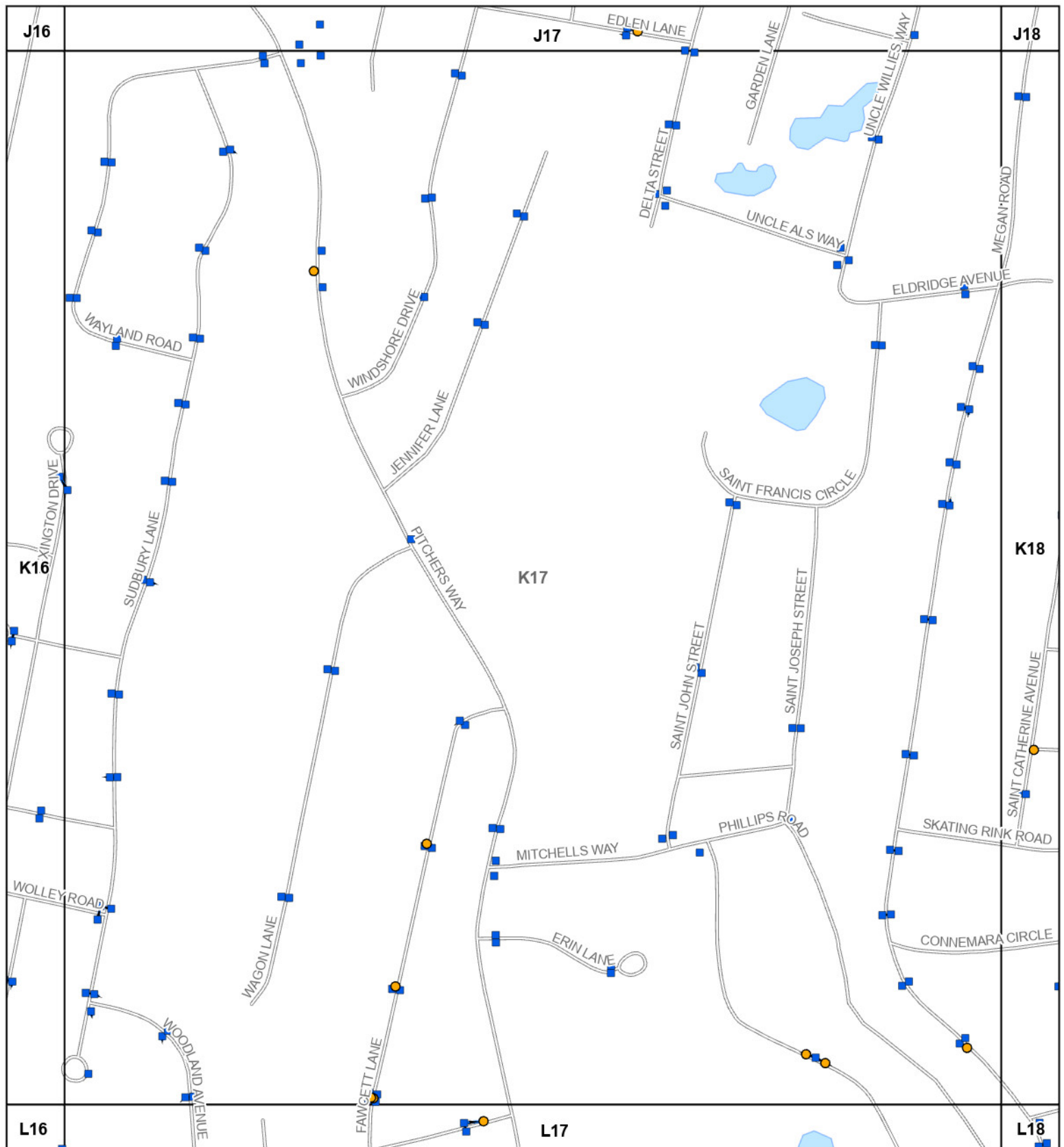
Stormwater Infrastructure Map Barnstable, MA

SHEET
K16

0 100 200 300 400 500
Feet



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| ▲ Outfalls | ○ DOT Manhole |
| ■ Catch Basin | ■ DOT Catch Basin |
| ● Drainage Manhole | — Storm Water Gravity Drain |
| ■ Stormwater BMP | ~ Swale |
| ★ Key Drainage Manhole | ○ Catchment |
| ✚ Interconnections | ○ Non-Urban Area |
| ▲ DOT Outfall | |

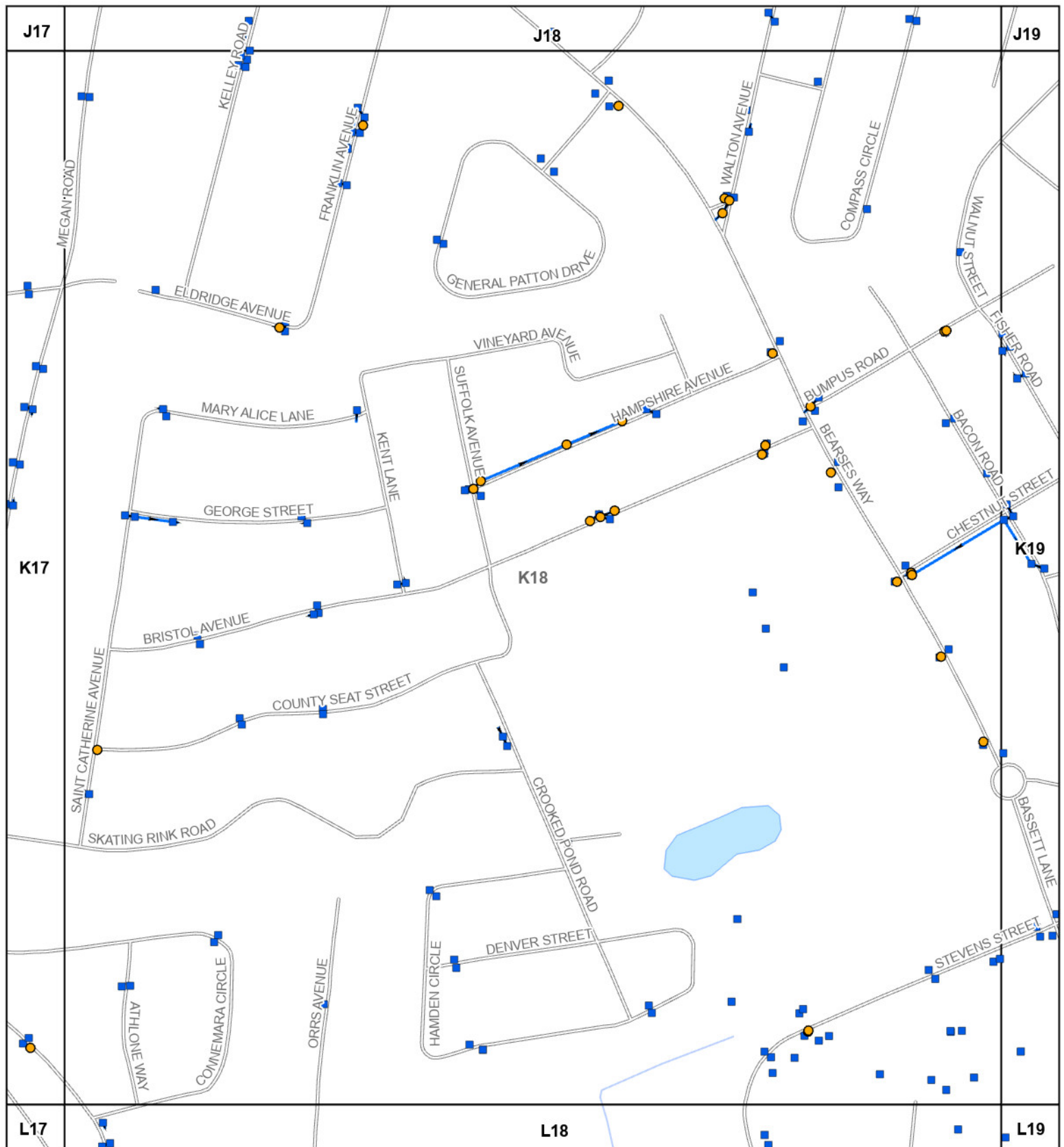
Stormwater Infrastructure Map Barnstable, MA

SHEET
K17

0 100 200 300 400 500
Feet



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| ▲ Outfalls | ● DOT Manhole |
| ■ Catch Basin | ■ DOT Catch Basin |
| ● Drainage Manhole | — Storm Water Gravity Drain |
| ■ Stormwater BMP | — Swale |
| ★ Key Drainage Manhole | — Catchment |
| ✚ Interconnections | — Non-Urban Area |
| ▲ DOT Outfall | |

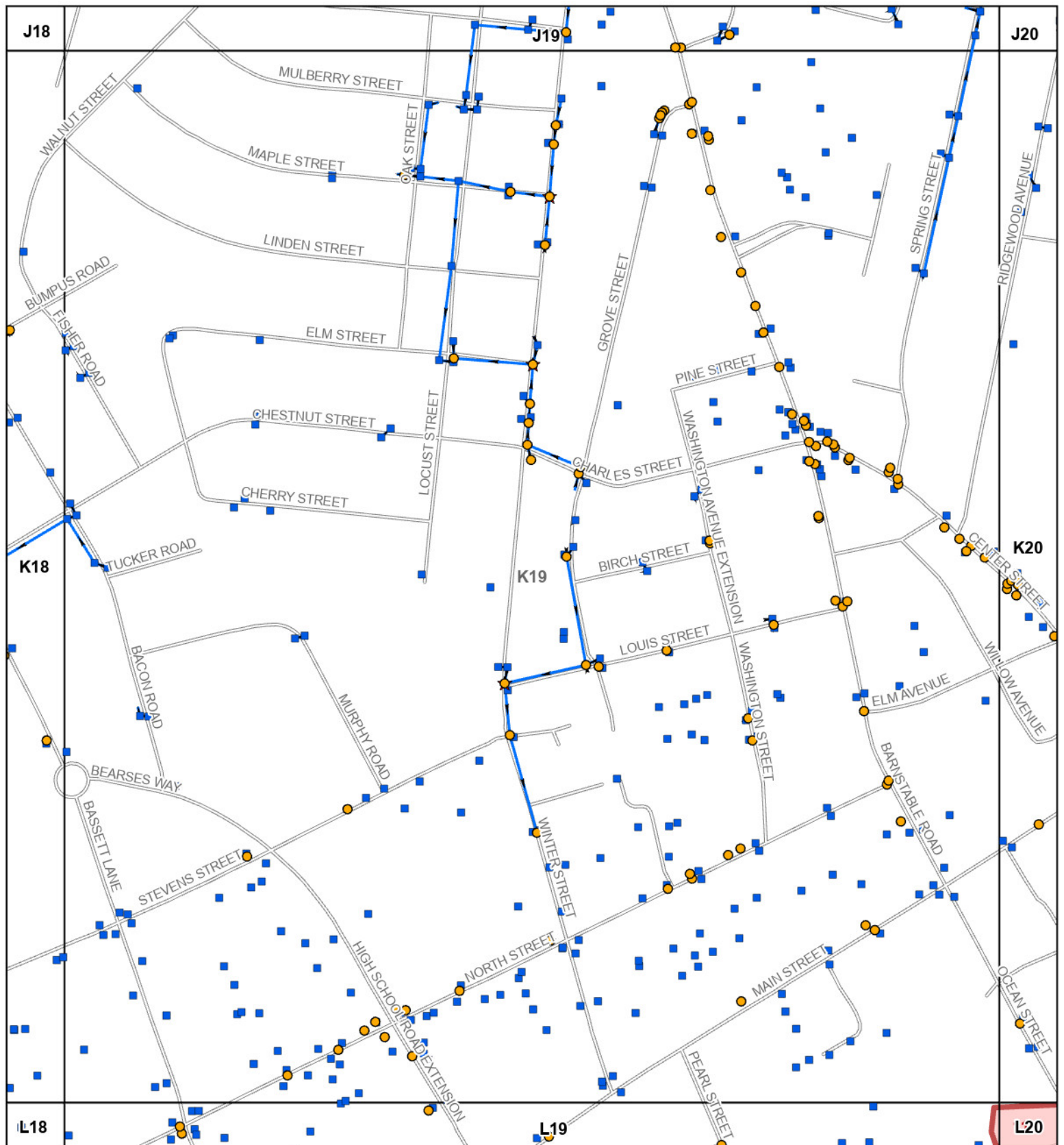
Stormwater Infrastructure Map Barnstable, MA

SHEET
K18

0 100 200 300 400 500
Feet



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| ▲ Outfalls | ○ DOT Manhole |
| ■ Catch Basin | ■ DOT Catch Basin |
| ● Drainage Manhole | — Storm Water Gravity Drain |
| ■ Stormwater BMP | — Swale |
| ★ Key Drainage Manhole | — Catchment |
| ✚ Interconnections | — Non-Urban Area |
| ▲ DOT Outfall | |

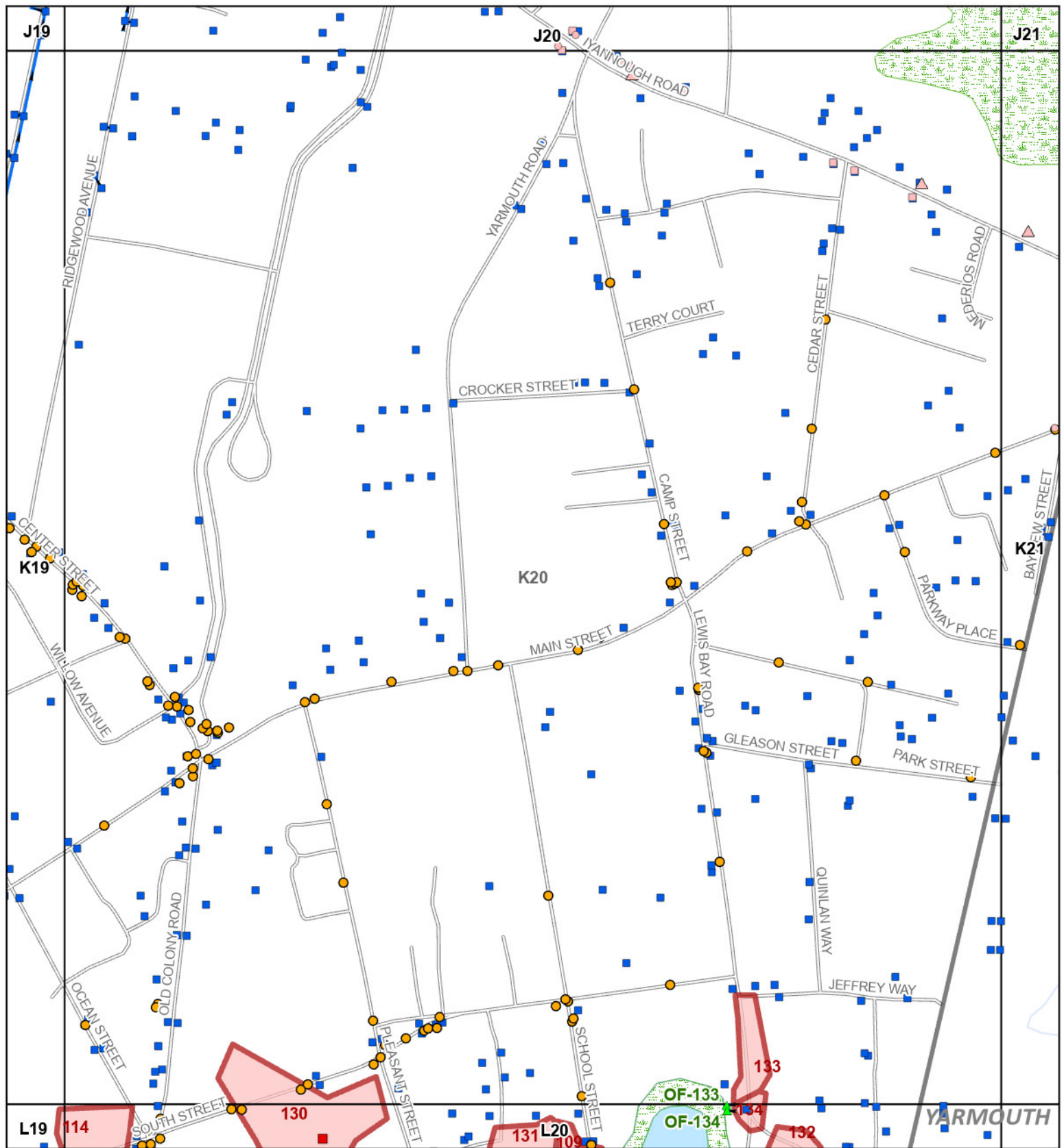
Stormwater Infrastructure Map Barnstable, MA

SHEET
K19

0 100 200 300 400 500
Feet



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| ▲ Outfalls | ○ DOT Manhole |
| ■ Catch Basin | ■ DOT Catch Basin |
| ● Drainage Manhole | — Storm Water Gravity Drain |
| ■ Stormwater BMP | — Swale |
| ★ Key Drainage Manhole | — Catchment |
| ✚ Interconnections | — Non-Urban Area |
| ▲ DOT Outfall | |

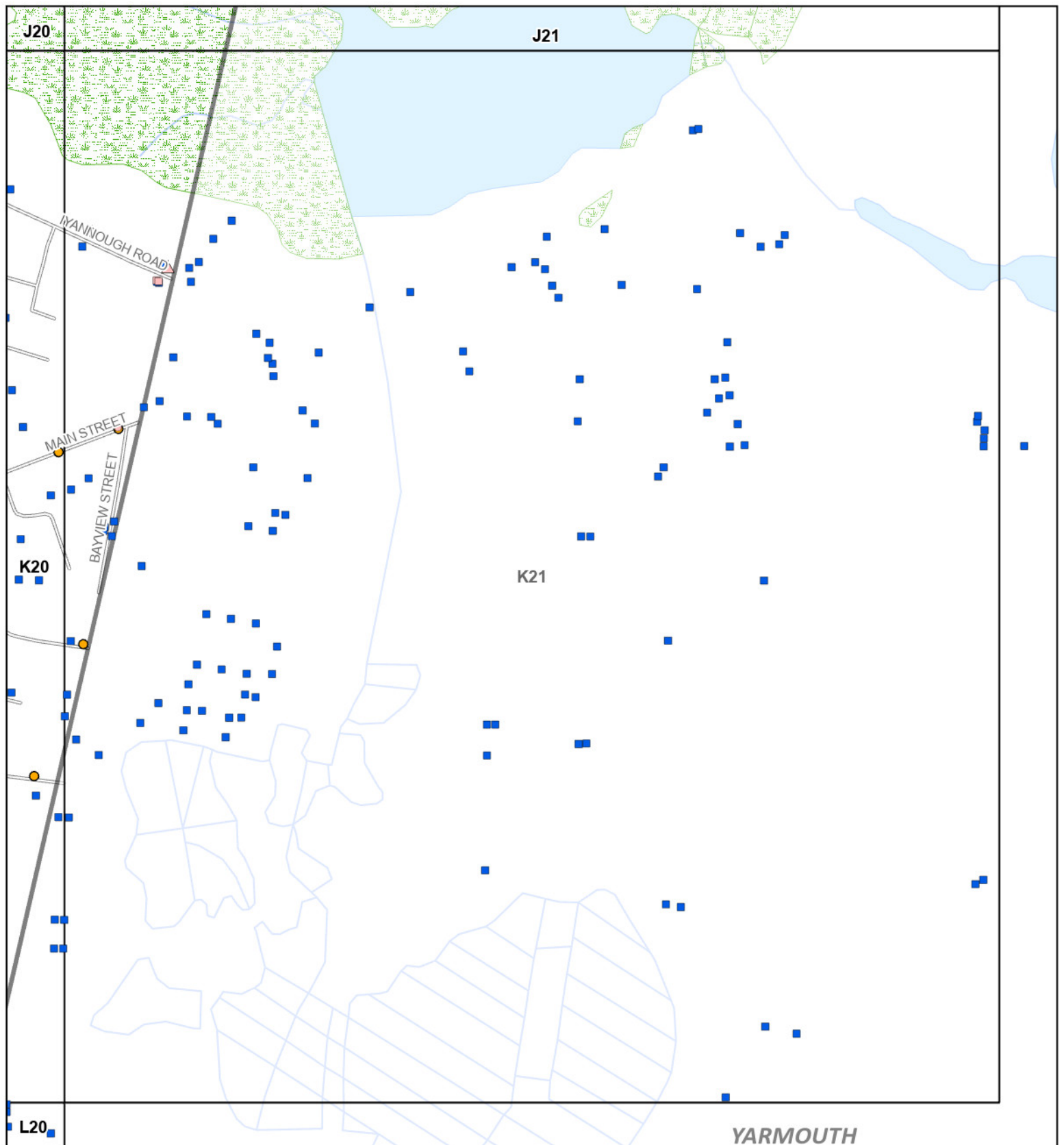
Stormwater Infrastructure Map Barnstable, MA

SHEET
K20

0 100 200 300 400 500
Feet



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| ▲ Outfalls | ● DOT Manhole |
| ■ Catch Basin | ■ DOT Catch Basin |
| ● Drainage Manhole | — Storm Water Gravity Drain |
| ■ Stormwater BMP | — Swale |
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| ✚ Interconnections | — Non-Urban Area |
| ▲ DOT Outfall | |

Stormwater Infrastructure Map Barnstable, MA

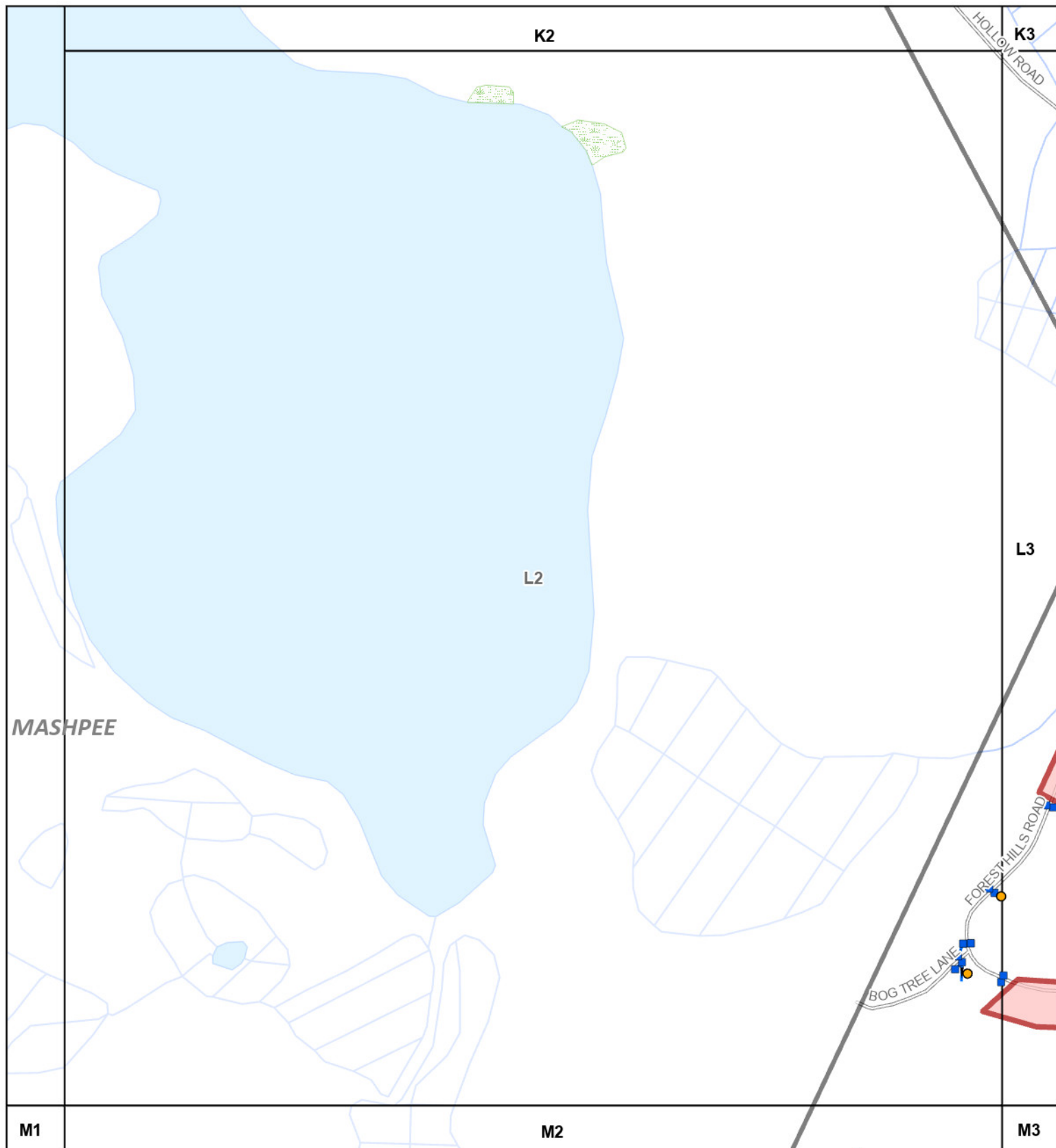
SHEET

K21

0 100 200 300 400 500
Feet



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| ▲ Outfalls | ● DOT Manhole |
| ■ Catch Basin | ■ DOT Catch Basin |
| ● Drainage Manhole | — Storm Water Gravity Drain |
| ■ Stormwater BMP | — Swale |
| ★ Key Drainage Manhole | — Catchment |
| ✚ Interconnections | — Non-Urban Area |
| ▲ DOT Outfall | |

Stormwater Infrastructure Map Barnstable, MA

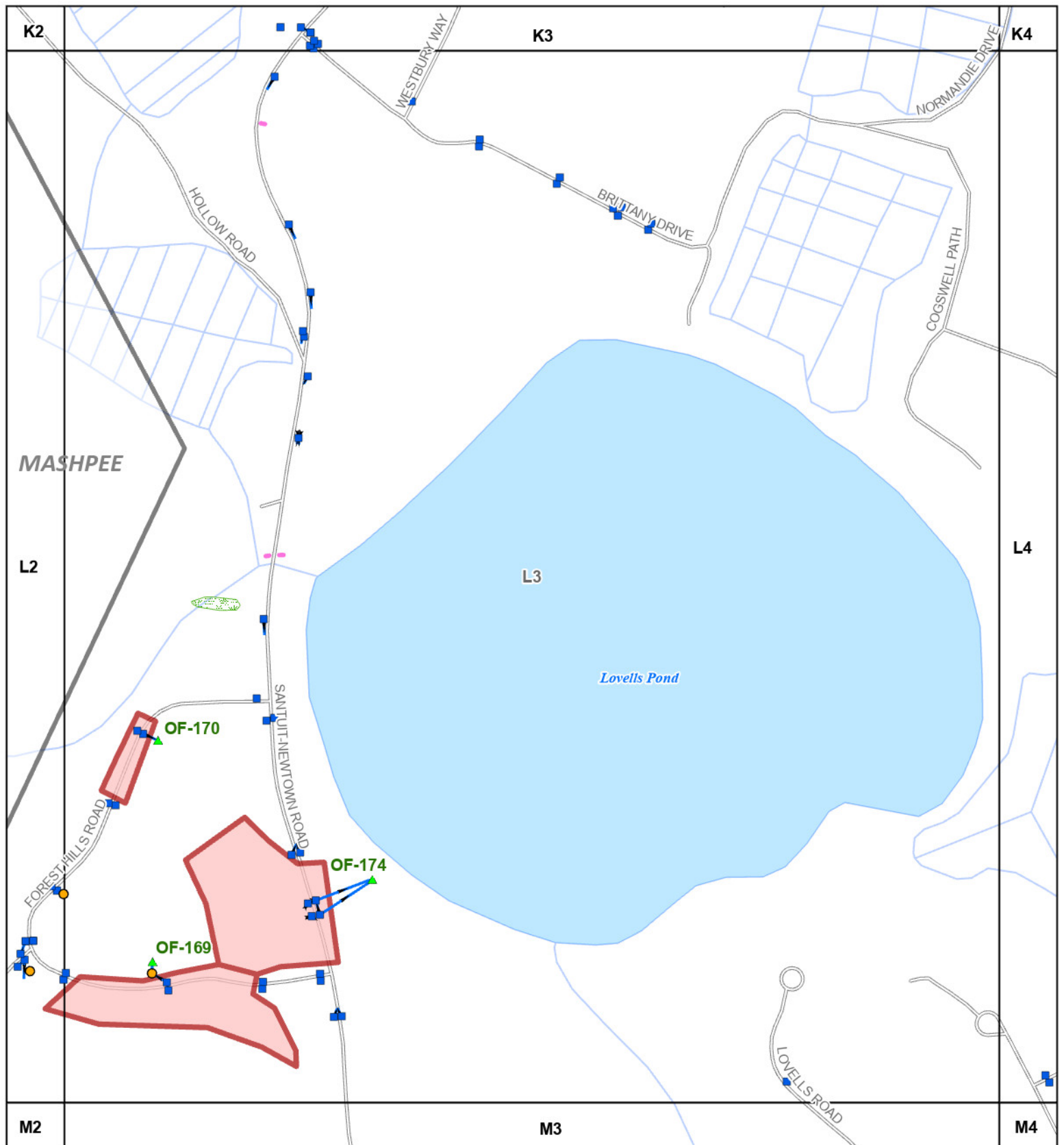
SHEET

L2

0 100 200 300 400 500
Feet



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| ▲ Outfalls | ○ DOT Manhole |
| ■ Catch Basin | ■ DOT Catch Basin |
| ● Drainage Manhole | — Storm Water Gravity Drain |
| ■ Stormwater BMP | — Swale |
| ★ Key Drainage Manhole | — Catchment |
| ✚ Interconnections | — Non-Urban Area |
| △ DOT Outfall | |

Stormwater Infrastructure Map Barnstable, MA

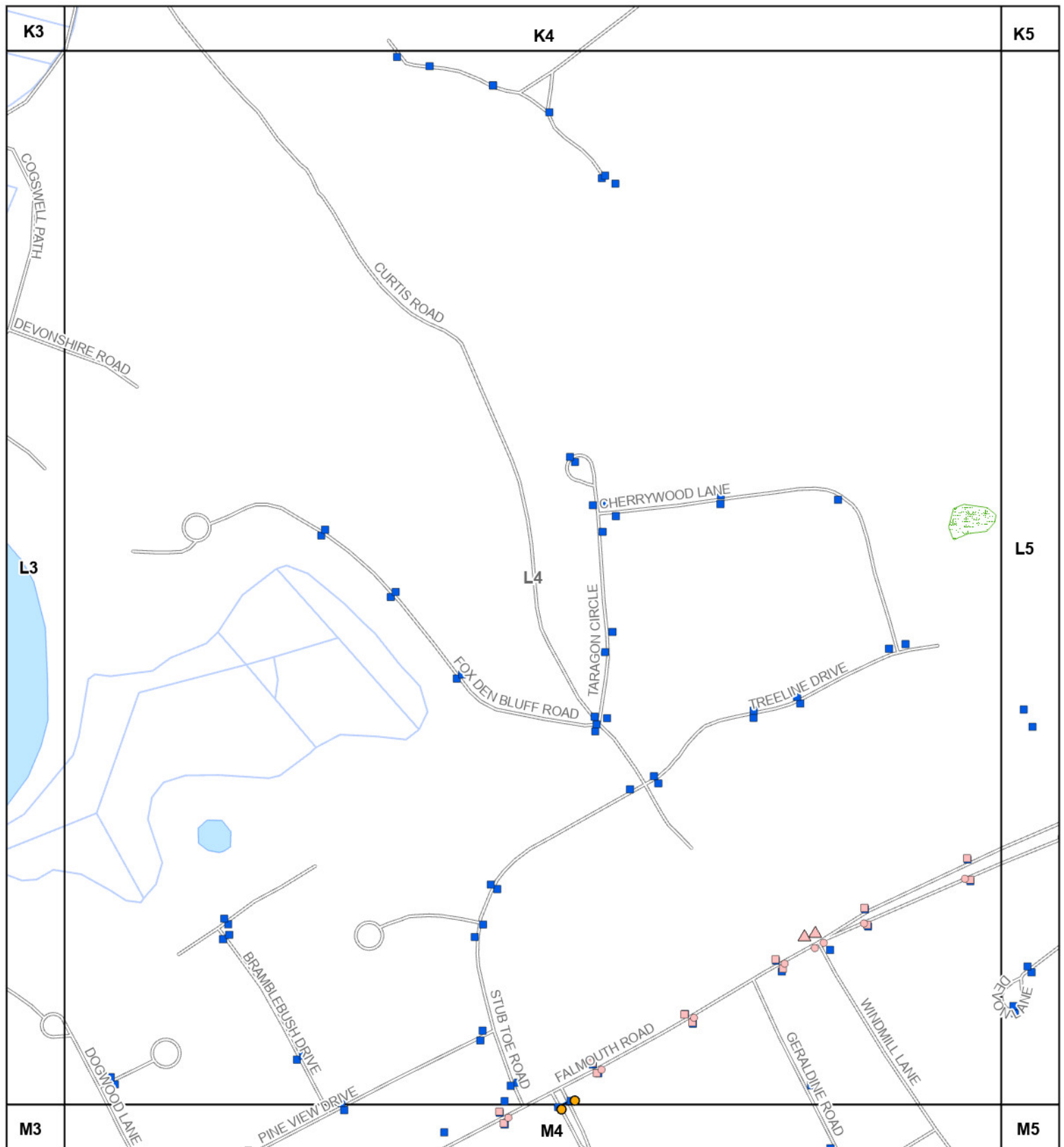
SHEET

L3

0 100 200 300 400 500
Feet



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Incorporated



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| ● Drainage Manhole | — Storm Water Gravity Drain |
| ■ Stormwater BMP | ~ Swale |
| ★ Key Drainage Manhole | ○ Catchment |
| ✚ Interconnections | ☁ Non-Urban Area |
| ▲ DOT Outfall | |

Stormwater Infrastructure Map Barnstable, MA

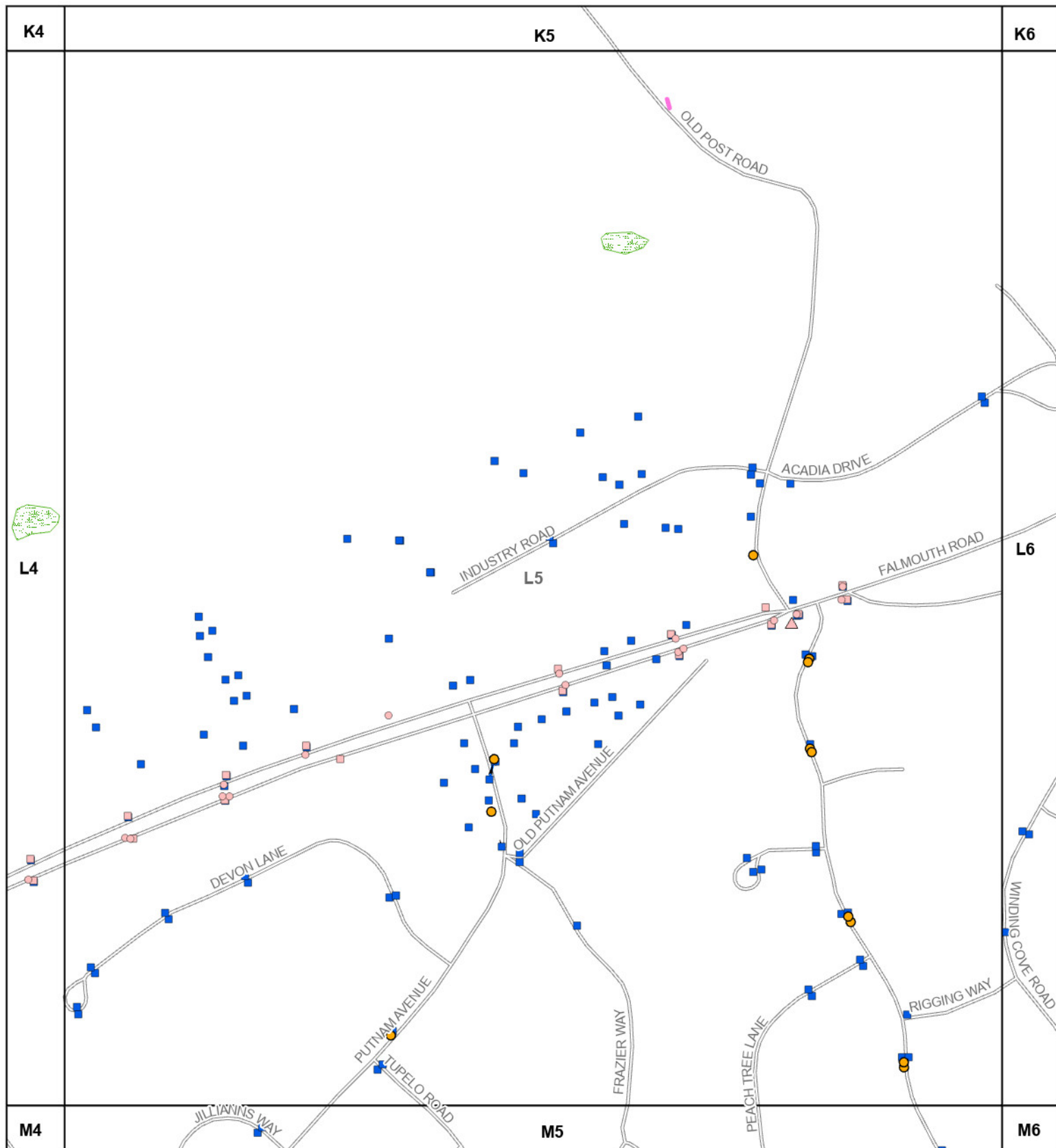
SHEET

L4

0 100 200 300 400 500
Feet



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| ● Drainage Manhole | — Storm Water Gravity Drain |
| ■ Stormwater BMP | — Swale |
| ★ Key Drainage Manhole | — Catchment |
| ✚ Interconnections | — Non-Urban Area |
| ▲ DOT Outfall | |

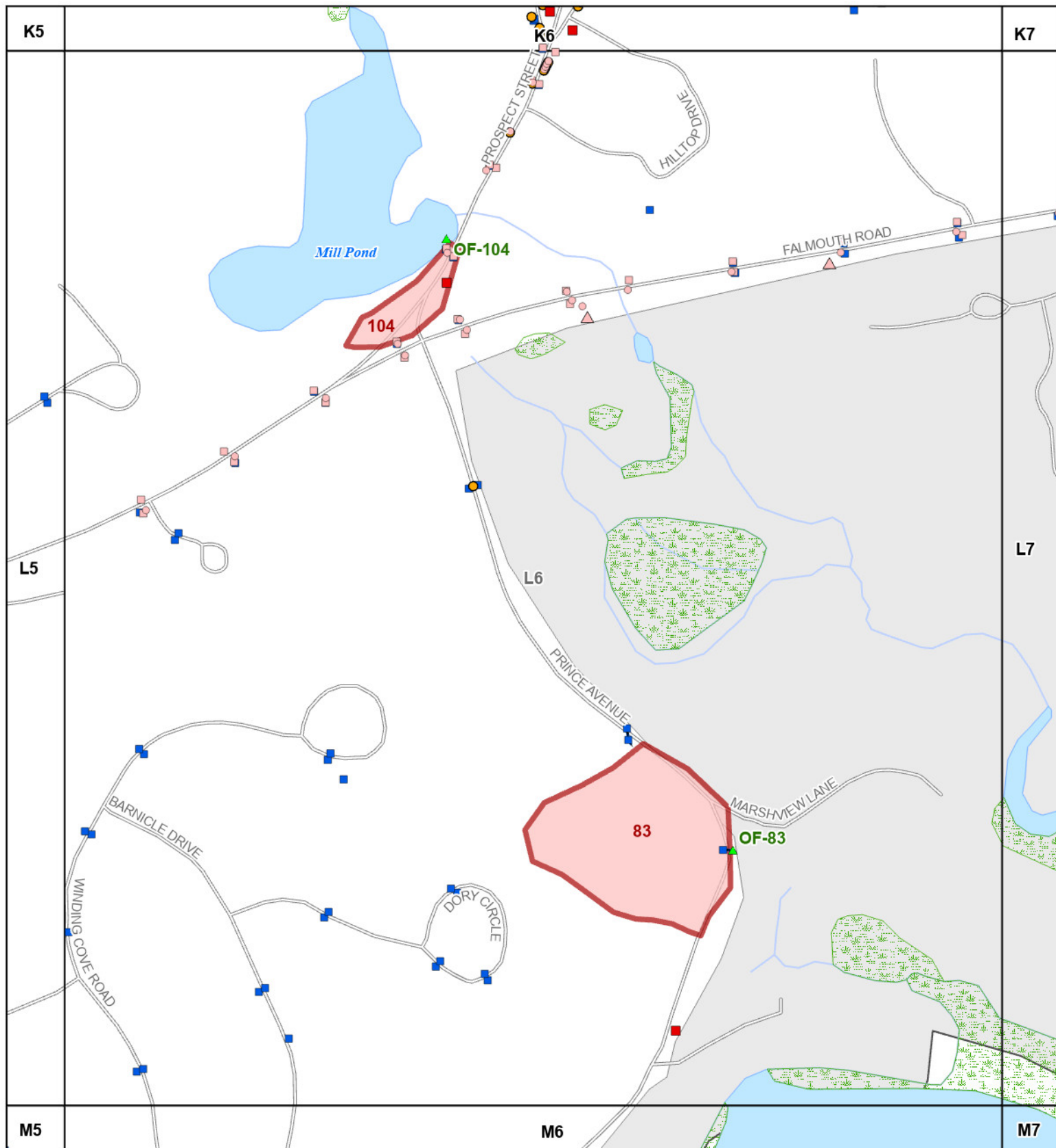
Stormwater Infrastructure Map Barnstable, MA

SHEET
L5

0 100 200 300 400 500
Feet



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| ▲ Outfalls | ○ DOT Manhole |
| ■ Catch Basin | ■ DOT Catch Basin |
| ● Drainage Manhole | — Storm Water Gravity Drain |
| ■ Stormwater BMP | — Swale |
| ★ Key Drainage Manhole | — Catchment |
| ✚ Interconnections | — Non-Urban Area |
| ▲ DOT Outfall | |

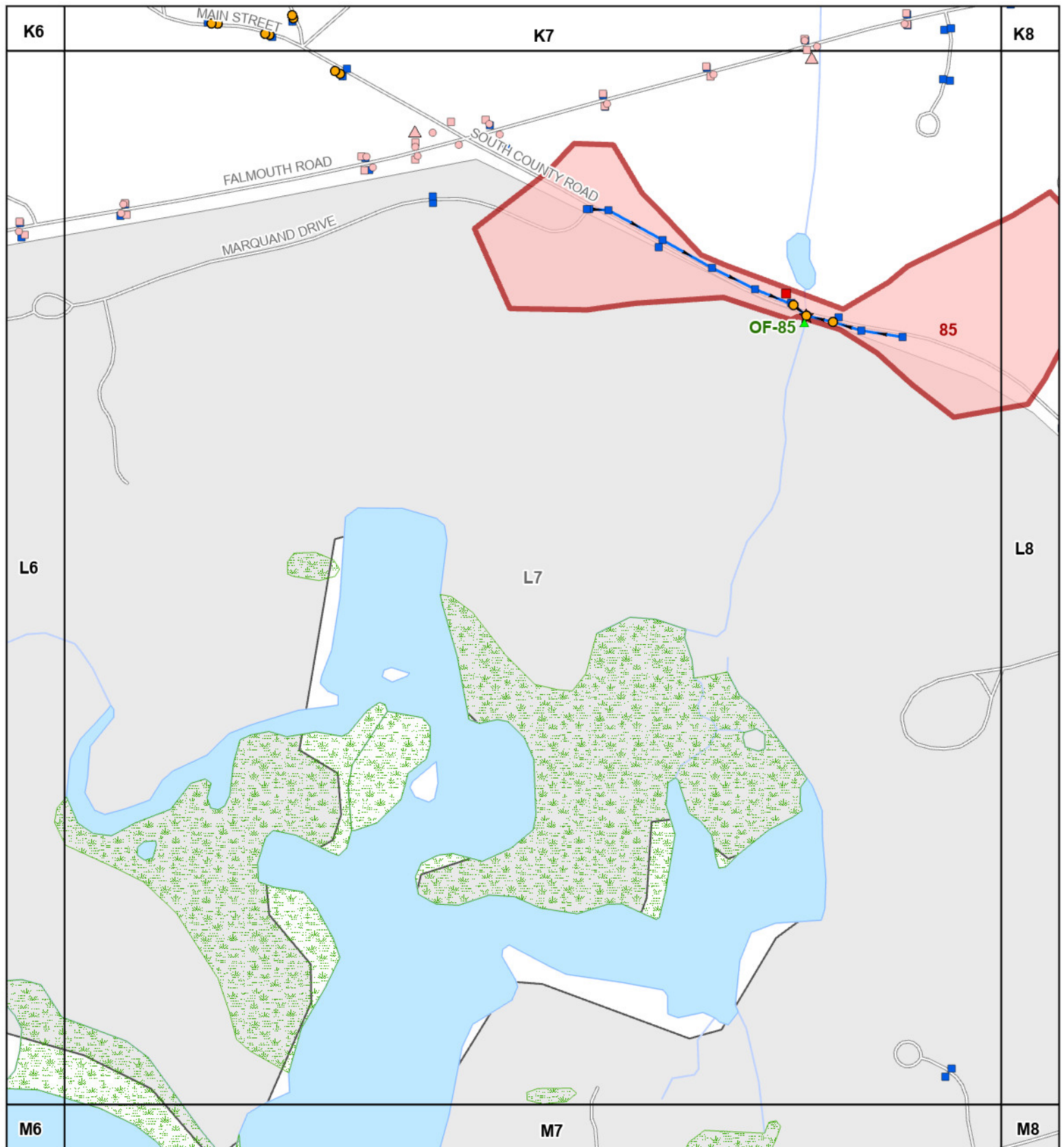
Stormwater Infrastructure Map Barnstable, MA

SHEET
L6

0 100 200 300 400 500
Feet



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| ▲ Outfalls | ● DOT Manhole |
| ■ Catch Basin | ■ DOT Catch Basin |
| ● Drainage Manhole | — Storm Water Gravity Drain |
| ■ Stormwater BMP | — Swale |
| ★ Key Drainage Manhole | — Catchment |
| ✚ Interconnections | — Non-Urban Area |
| ▲ DOT Outfall | |

Stormwater Infrastructure Map Barnstable, MA

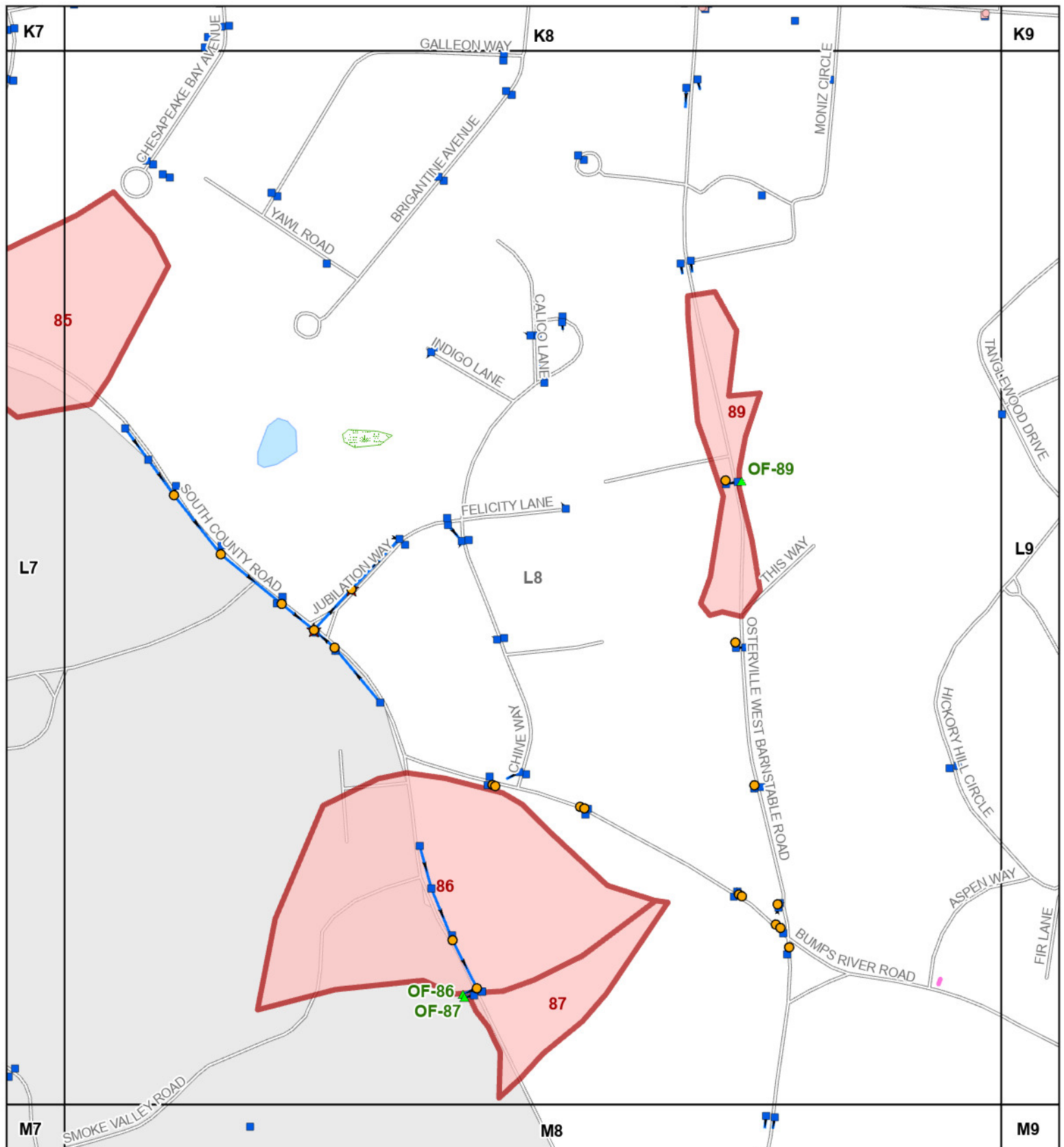
SHEET

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Feet



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| ▲ Outfalls | ● DOT Manhole |
| ■ Catch Basin | ■ DOT Catch Basin |
| ● Drainage Manhole | — Storm Water Gravity Drain |
| ■ Stormwater BMP | — Swale |
| ★ Key Drainage Manhole | — Catchment |
| ✚ Interconnections | — Non-Urban Area |
| ▲ DOT Outfall | |

Stormwater Infrastructure Map Barnstable, MA

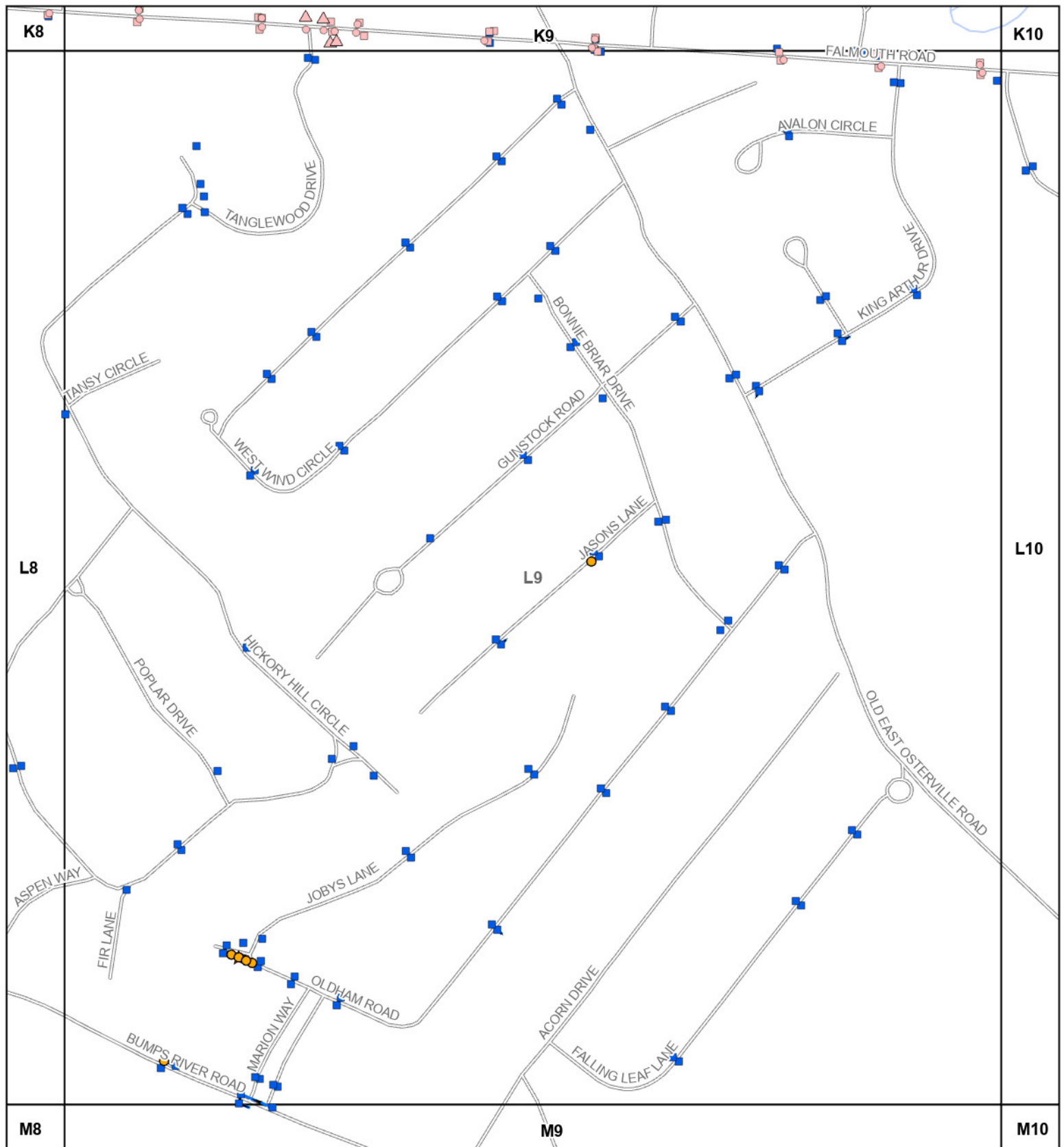
SHEET

L8

0 100 200 300 400 500
Feet



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Incorporated



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| ▲ Outfalls | ● DOT Manhole |
| ■ Catch Basin | ■ DOT Catch Basin |
| ● Drainage Manhole | — Storm Water Gravity Drain |
| ■ Stormwater BMP | — Swale |
| ★ Key Drainage Manhole | — Catchment |
| ✚ Interconnections | — Non-Urban Area |
| ▲ DOT Outfall | |

Stormwater Infrastructure Map Barnstable, MA

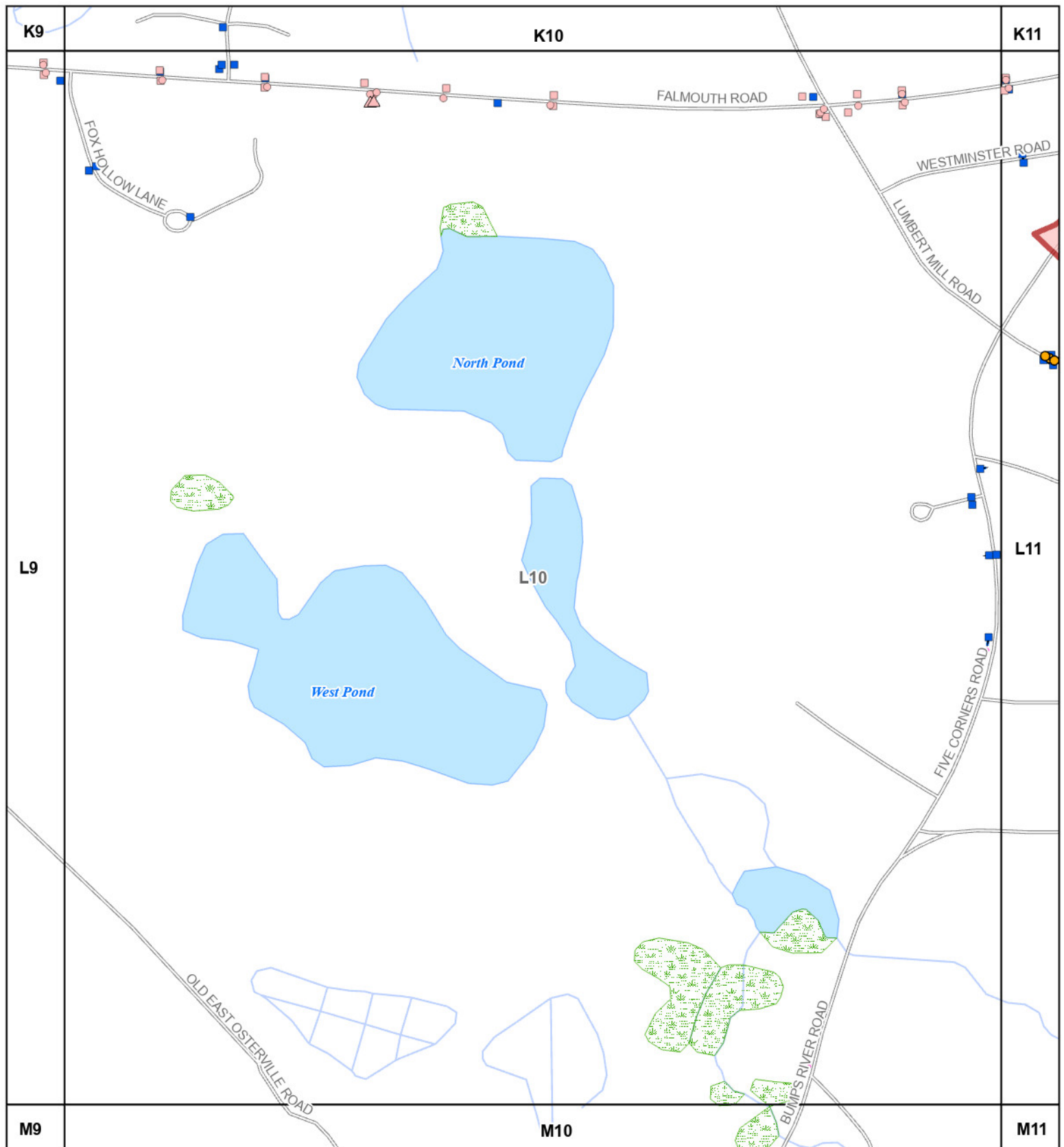
SHEET

L9

0 100 200 300 400 500
Feet



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Environmental
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| ▲ Outfalls | ● DOT Manhole |
| ■ Catch Basin | ■ DOT Catch Basin |
| ● Drainage Manhole | — Storm Water Gravity Drain |
| ■ Stormwater BMP | — Swale |
| ★ Key Drainage Manhole | — Catchment |
| ✚ Interconnections | — Non-Urban Area |
| ▲ DOT Outfall | |

Stormwater Infrastructure Map Barnstable, MA

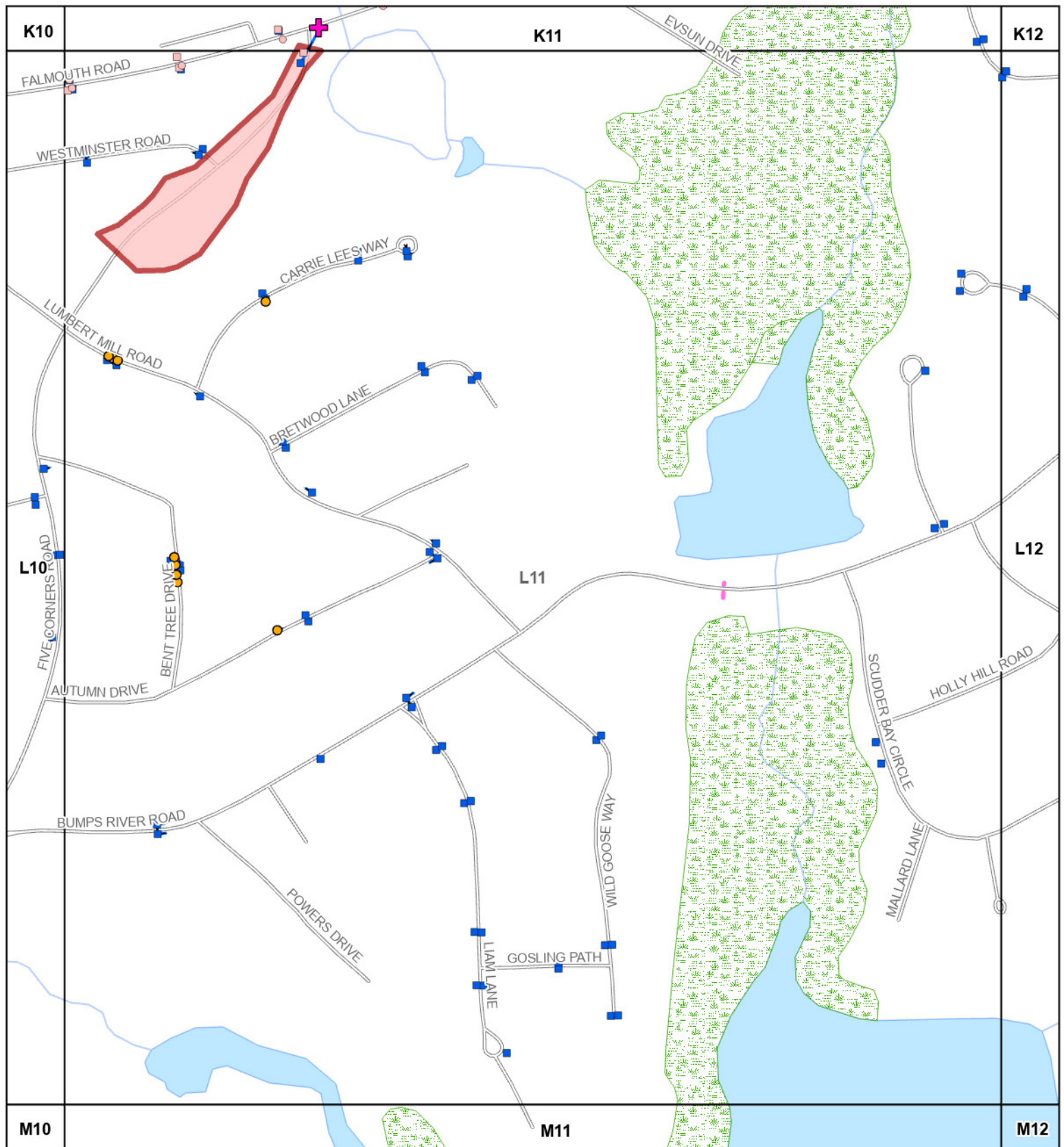
SHEET

L10

0 100 200 300 400 500
Feet



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Environmental
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| ■ Catch Basin | ■ DOT Catch Basin |
| ● Drainage Manhole | — Storm Water Gravity Drain |
| ■ Stormwater BMP | — Swale |
| ★ Key Drainage Manhole | — Catchment |
| ✚ Interconnections | — Non-Urban Area |
| ▲ DOT Outfall | |

Stormwater Infrastructure Map Barnstable, MA

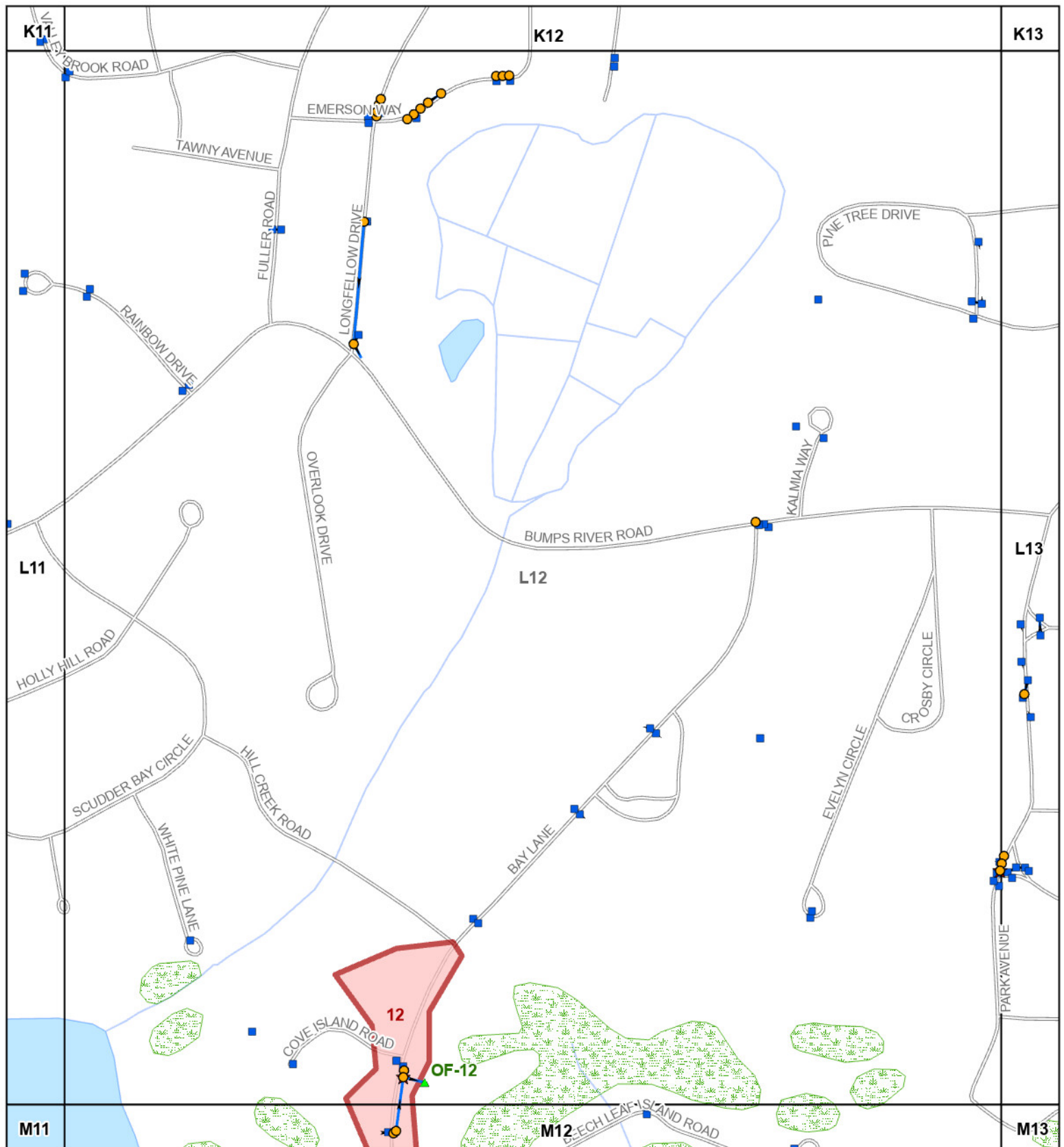
SHEET

L11

0 100 200 300 400 500
Feet



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Environmental
Incorporated



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| ▲ Outfalls | ○ DOT Manhole |
| ■ Catch Basin | ■ DOT Catch Basin |
| ● Drainage Manhole | — Storm Water Gravity Drain |
| ■ Stormwater BMP | — Swale |
| ★ Key Drainage Manhole | — Catchment |
| ✚ Interconnections | — Non-Urban Area |
| △ DOT Outfall | |

Stormwater Infrastructure Map Barnstable, MA

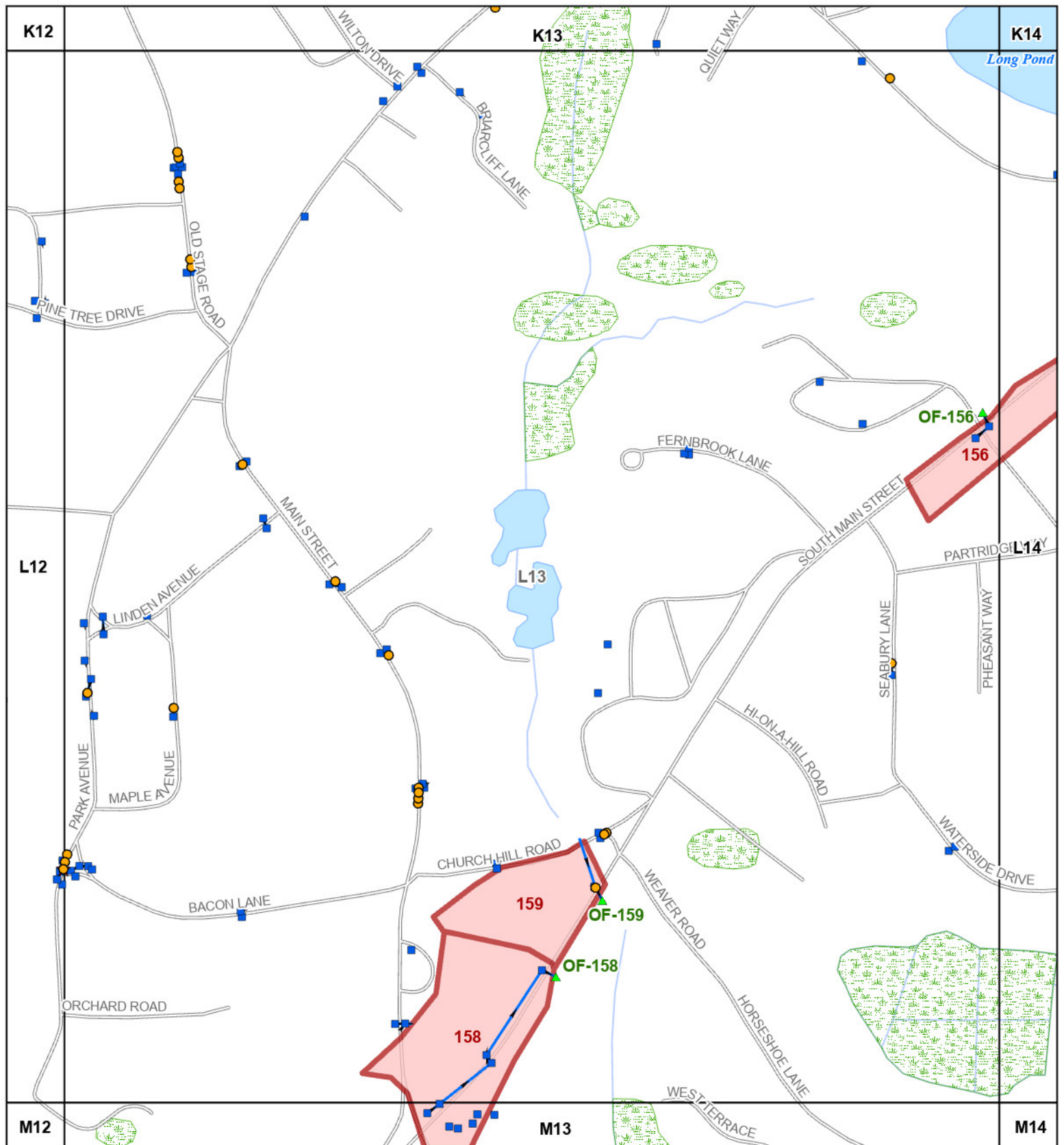
SHEET

L12

0 100 200 300 400 500
Feet



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Environmental
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| ■ Catch Basin | □ DOT Catch Basin |
| ● Drainage Manhole | — Storm Water Gravity Drain |
| ■ Stormwater BMP | — Swale |
| ★ Key Drainage Manhole | — Catchment |
| ✚ Interconnections | — Non-Urban Area |
| ▲ DOT Outfall | |

Stormwater Infrastructure Map Barnstable, MA

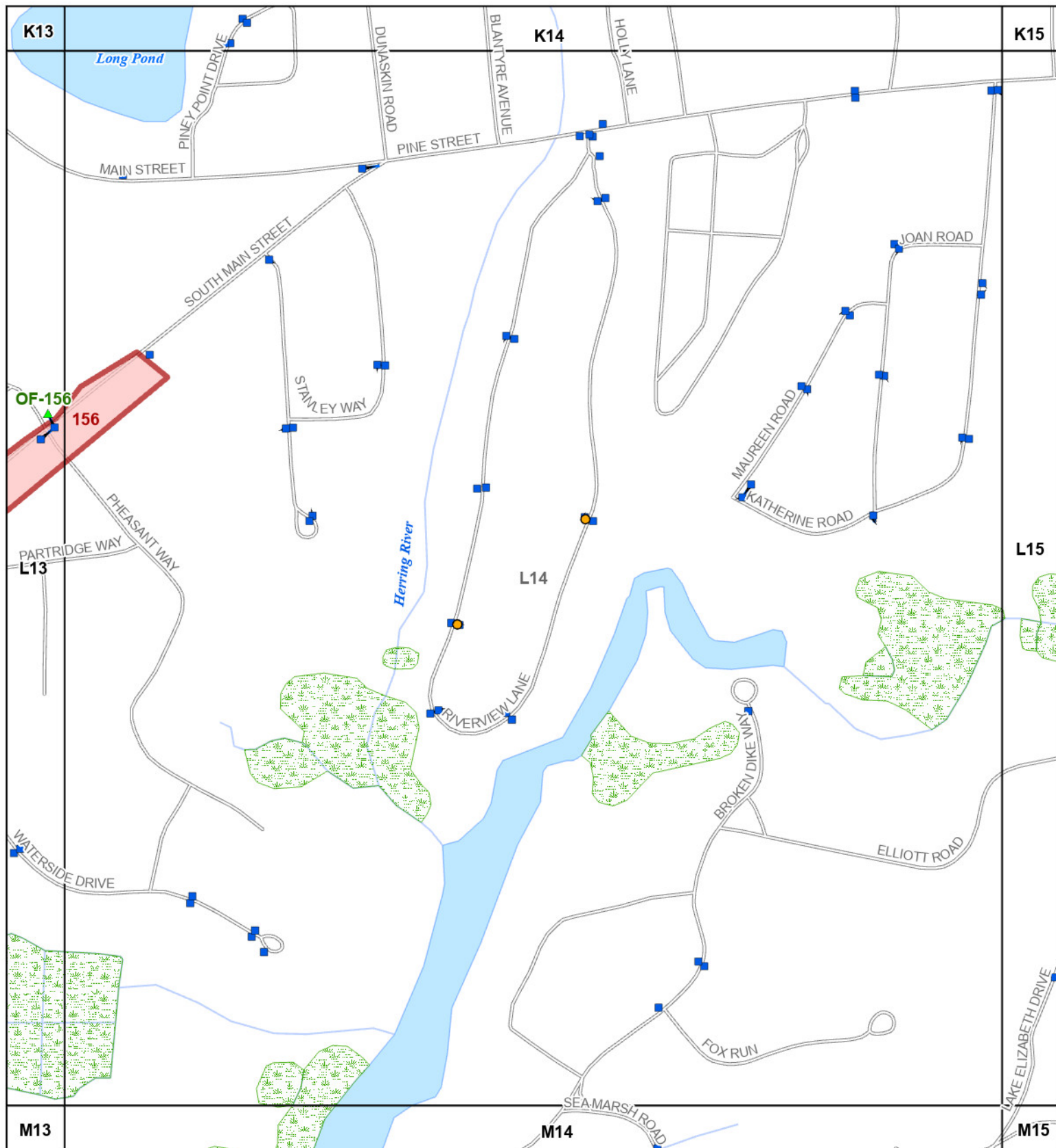
SHEET

L13

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Feet



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Environmental
Incorporated



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| ■ Catch Basin | ■ DOT Catch Basin |
| ● Drainage Manhole | — Storm Water Gravity Drain |
| ■ Stormwater BMP | — Swale |
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| ✚ Interconnections | — Non-Urban Area |
| ▲ DOT Outfall | |

Stormwater Infrastructure Map Barnstable, MA

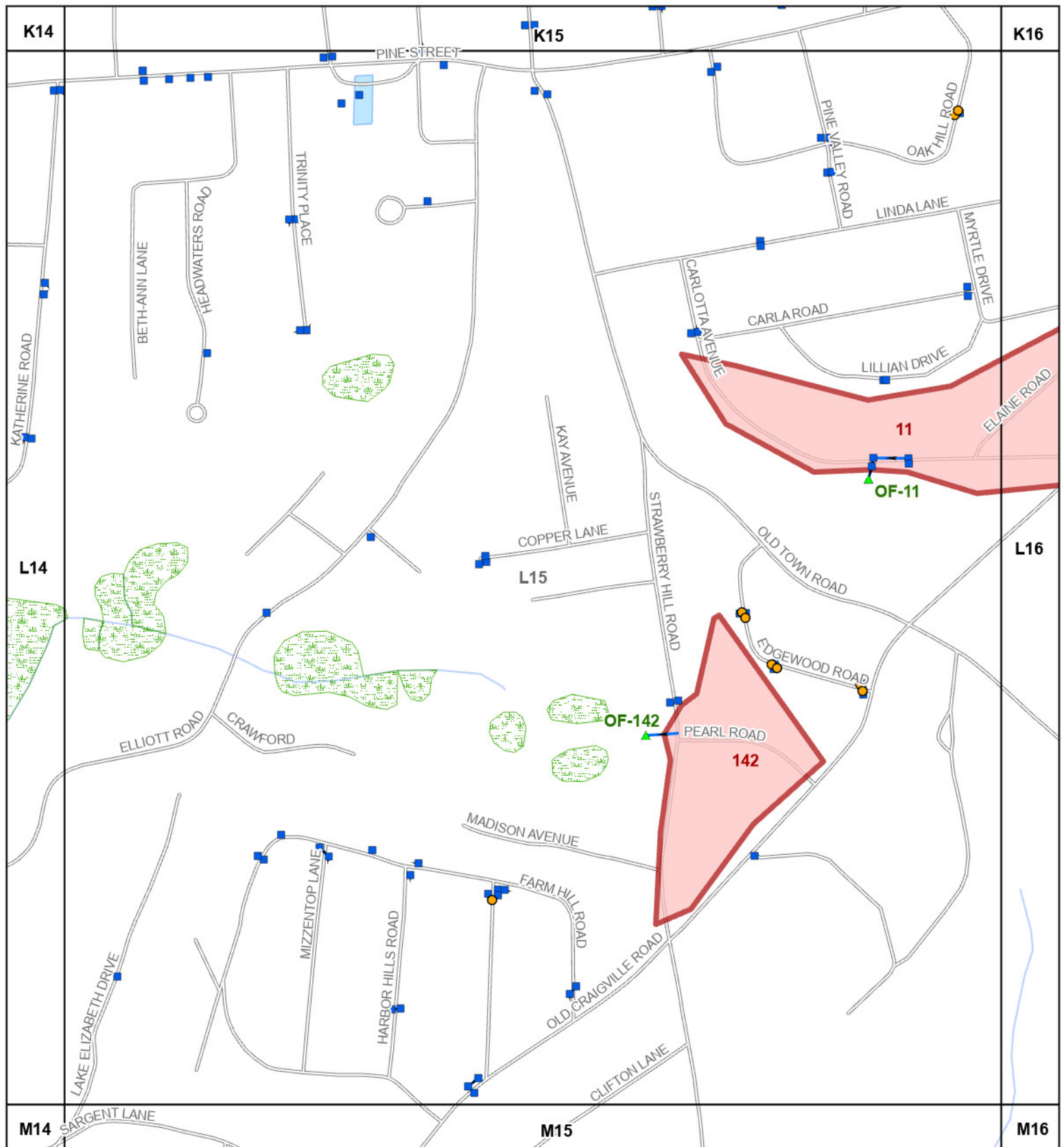
SHEET

L14

0 100 200 300 400 500
Feet



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Environmental
Incorporated



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| ● Drainage Manhole | — Storm Water Gravity Drain |
| ■ Stormwater BMP | — Swale |
| ★ Key Drainage Manhole | — Catchment |
| ✚ Interconnections | — Non-Urban Area |
| ▲ DOT Outfall | |

Stormwater Infrastructure Map Barnstable, MA

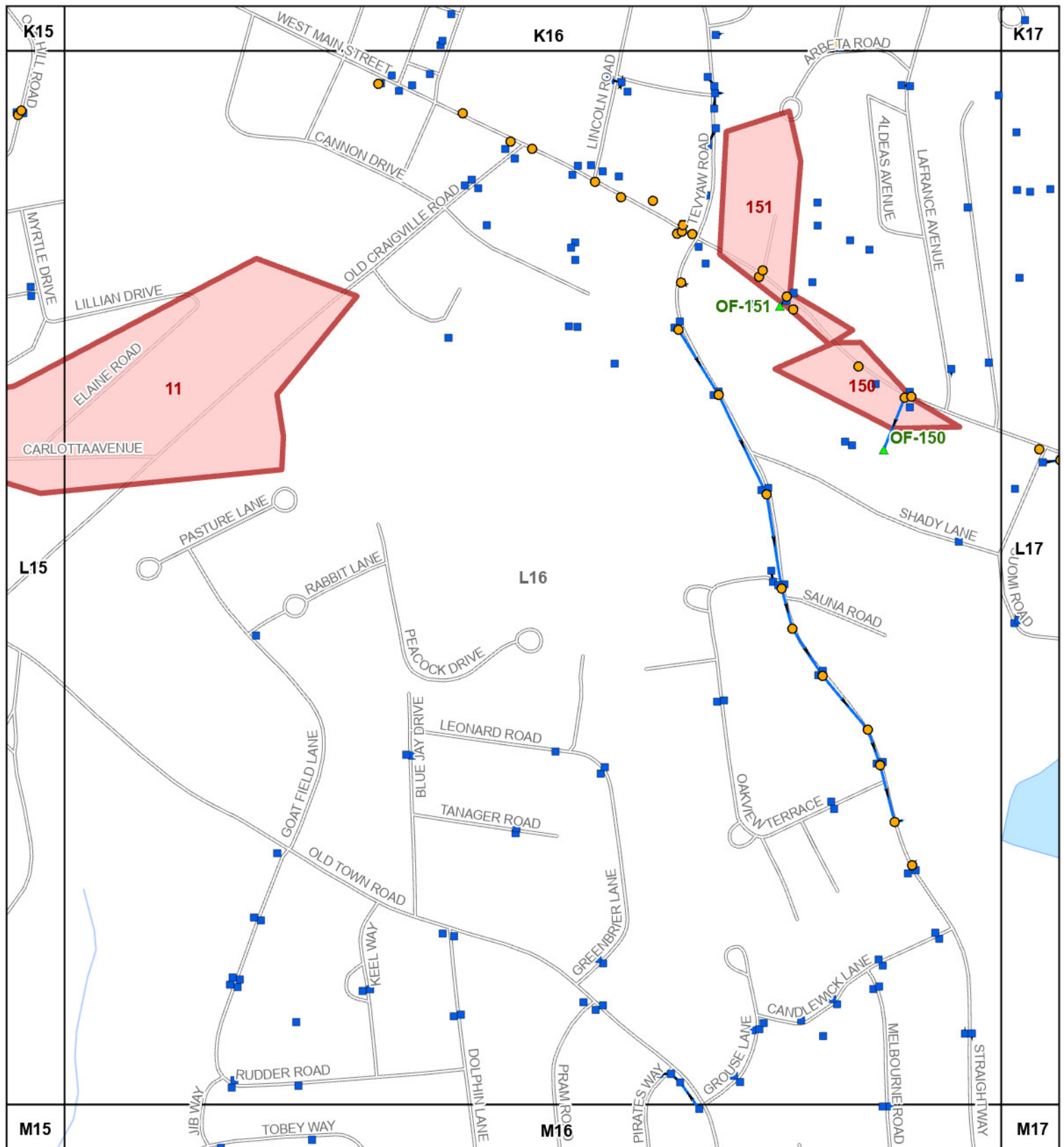
SHEET

L15

0 100 200 300 400 500
Feet



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Environmental
Incorporated



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| ● Drainage Manhole | — Storm Water Gravity Drain |
| ■ Stormwater BMP | — Swale |
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| ✚ Interconnections | — Non-Urban Area |
| ▲ DOT Outfall | |

Stormwater Infrastructure Map Barnstable, MA

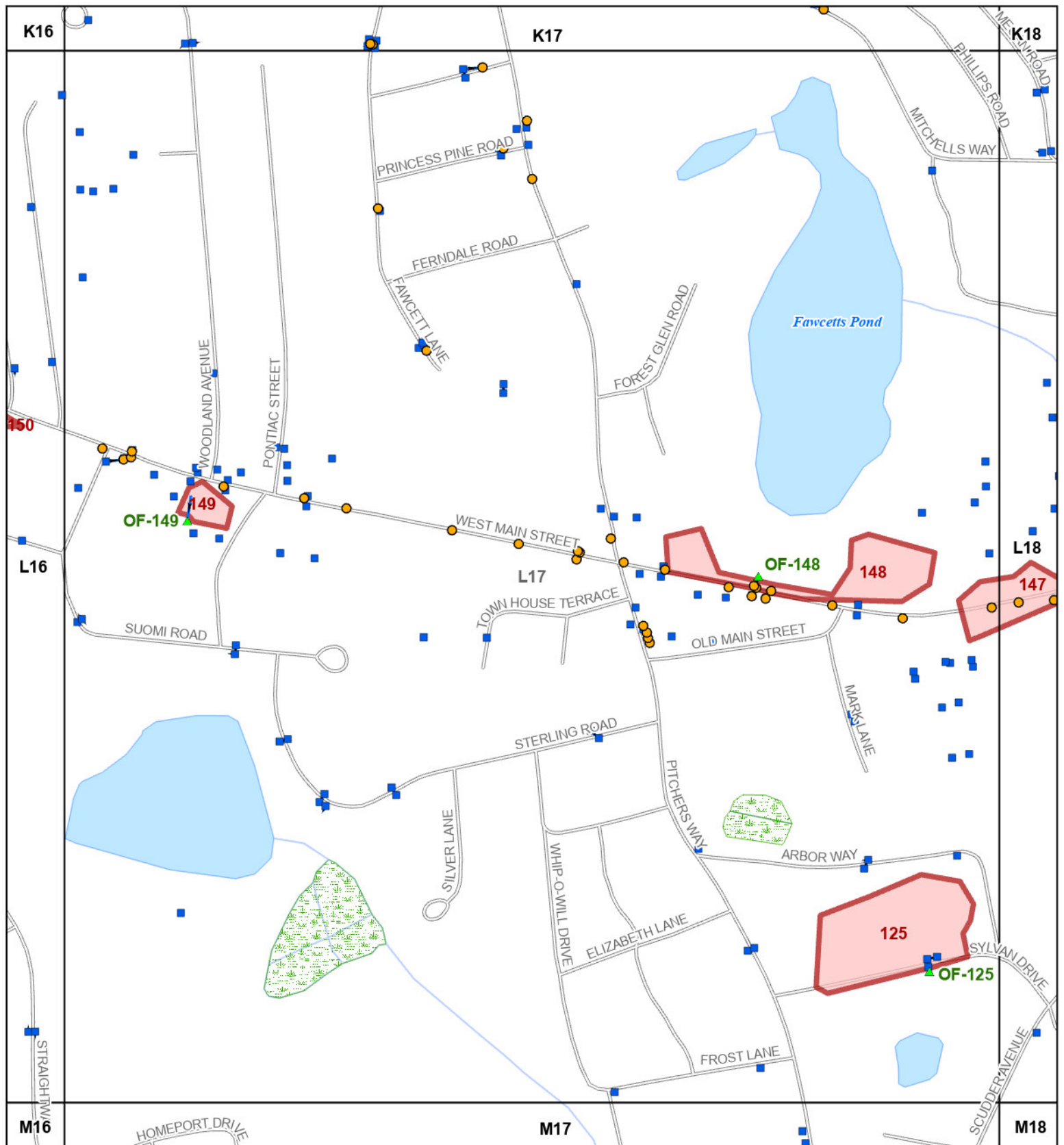
SHEET

L16

0 100 200 300 400 500
Feet



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Environmental
Incorporated



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| ▲ Outfalls | ○ DOT Manhole |
| ■ Catch Basin | ■ DOT Catch Basin |
| ● Drainage Manhole | — Storm Water Gravity Drain |
| ■ Stormwater BMP | — Swale |
| ★ Key Drainage Manhole | — Catchment |
| ✚ Interconnections | — Non-Urban Area |
| ▲ DOT Outfall | |

Stormwater Infrastructure Map Barnstable, MA

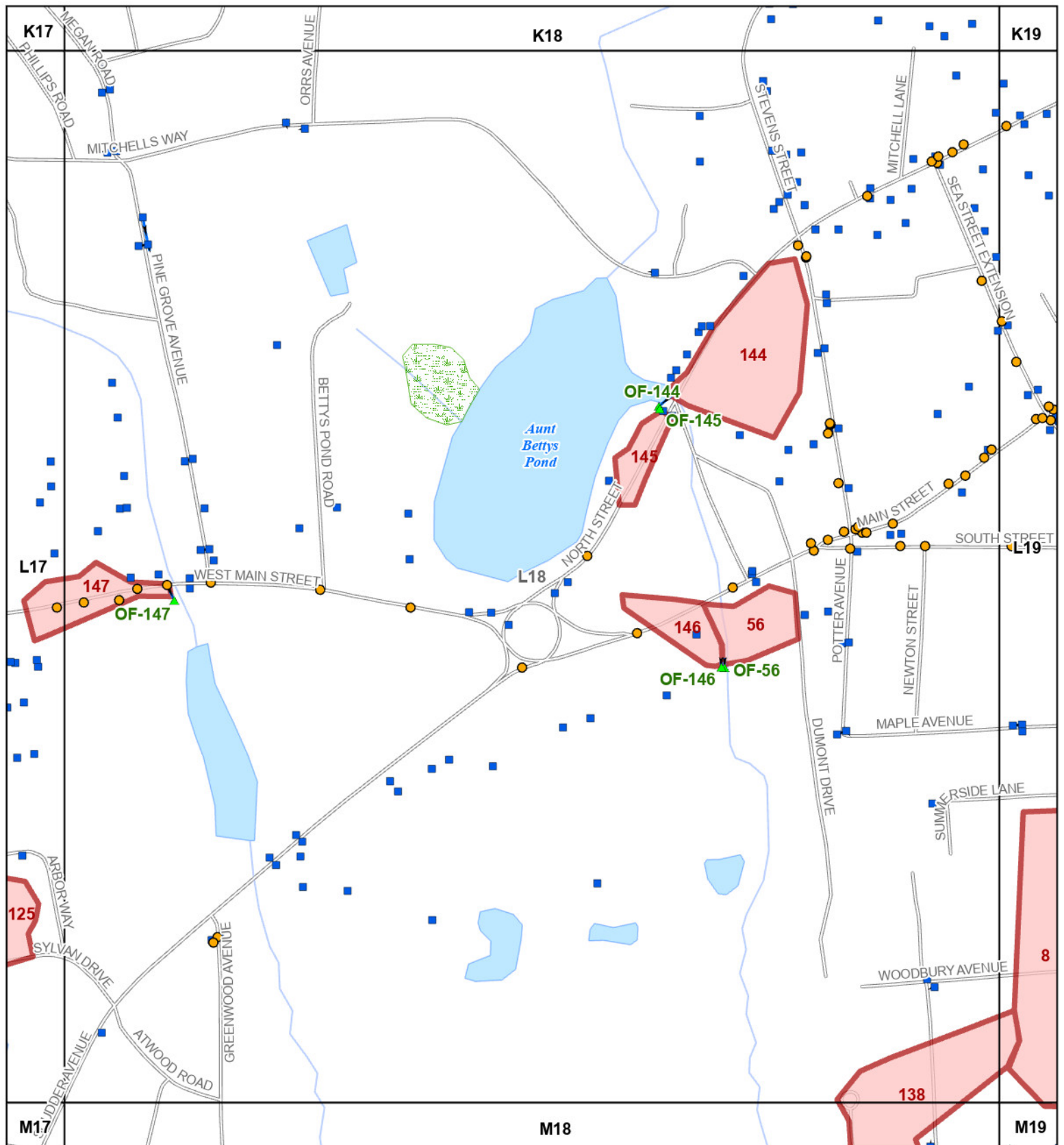
SHEET

L17

0 100 200 300 400 500
Feet



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Environmental
Incorporated



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| ■ Catch Basin | ■ DOT Catch Basin |
| ● Drainage Manhole | — Storm Water Gravity Drain |
| ■ Stormwater BMP | — Swale |
| ★ Key Drainage Manhole | — Catchment |
| ✚ Interconnections | — Non-Urban Area |
| ▲ DOT Outfall | |

Stormwater Infrastructure Map Barnstable, MA

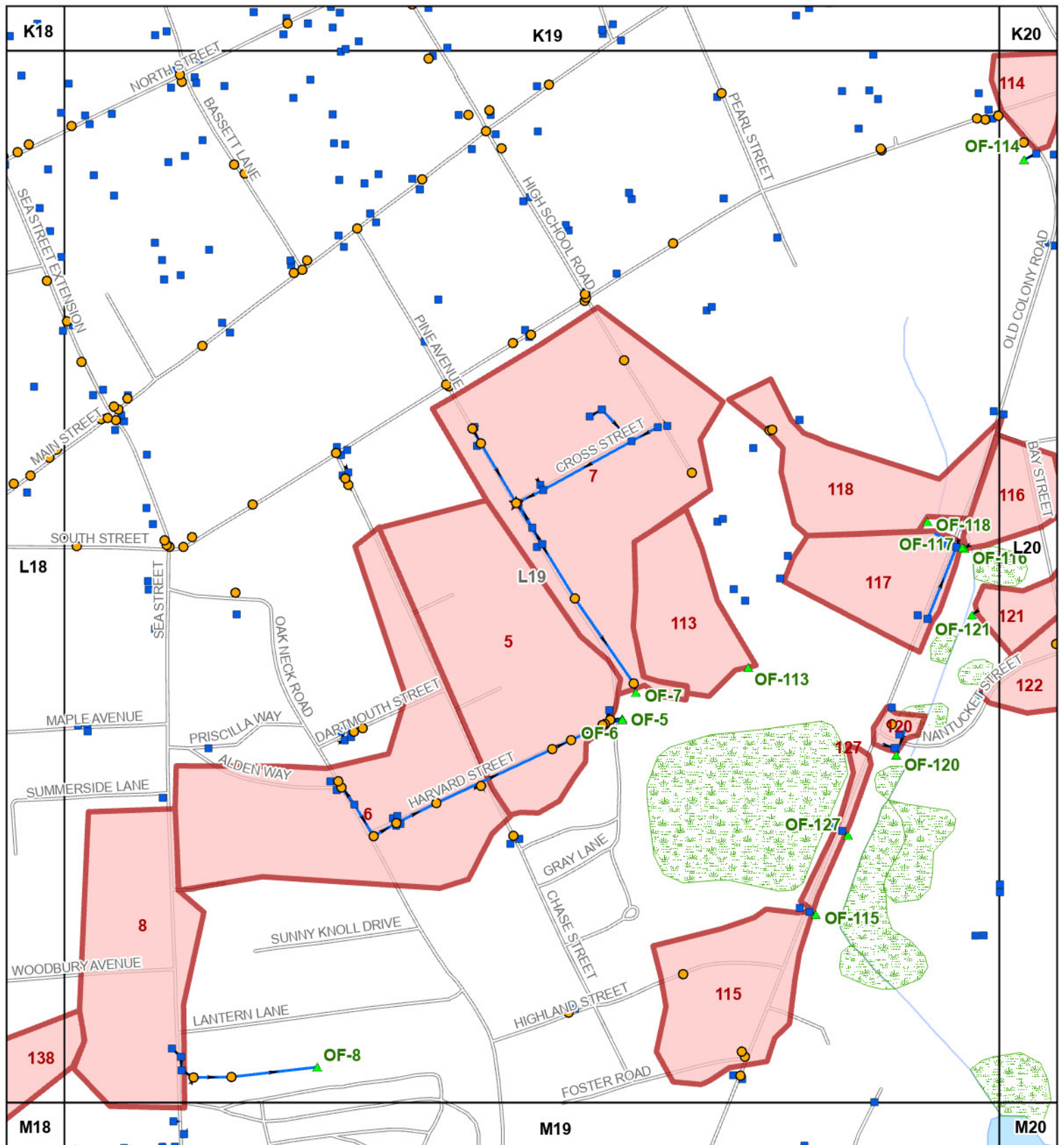
SHEET

L18

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Feet



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Environmental
Incorporated



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| ■ Catch Basin | ■ DOT Catch Basin |
| ● Drainage Manhole | — Storm Water Gravity Drain |
| ■ Stormwater BMP | — Swale |
| ★ Key Drainage Manhole | — Catchment |
| ✚ Interconnections | — Non-Urban Area |
| ▲ DOT Outfall | |

Stormwater Infrastructure Map Barnstable, MA

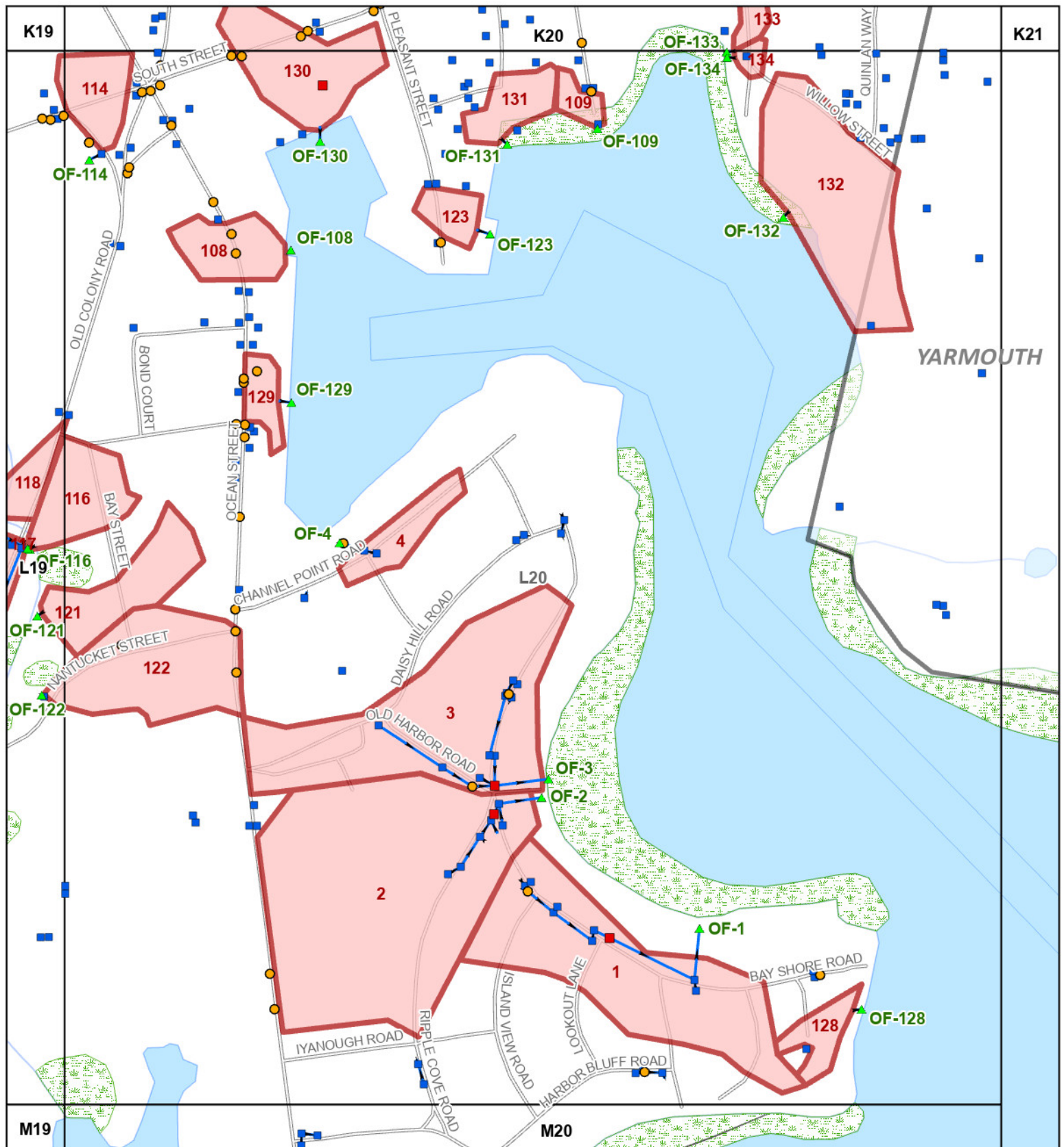
SHEET

L19

0 100 200 300 400 500
Feet



Comprehensive
Environmental
Incorporated



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| ■ Catch Basin | ■ DOT Catch Basin |
| ● Drainage Manhole | — Storm Water Gravity Drain |
| ■ Stormwater BMP | — Swale |
| ★ Key Drainage Manhole | — Catchment |
| ✚ Interconnections | — Non-Urban Area |
| ▲ DOT Outfall | |

Stormwater Infrastructure Map Barnstable, MA

SHEET

L20

0 100 200 300 400 500
Feet



Comprehensive
Environmental
Incorporated

M1

PHEASANT HILL CIRCLE

N1

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| ▲ Outfalls | ○ DOT Manhole |
| ■ Catch Basin | ■ DOT Catch Basin |
| ● Drainage Manhole | — Storm Water Gravity Drain |
| ■ Stormwater BMP | — Swale |
| ★ Key Drainage Manhole | — Catchment |
| ✚ Interconnections | — Non-Urban Area |
| ▲ DOT Outfall | |

Stormwater Infrastructure Map Barnstable, MA

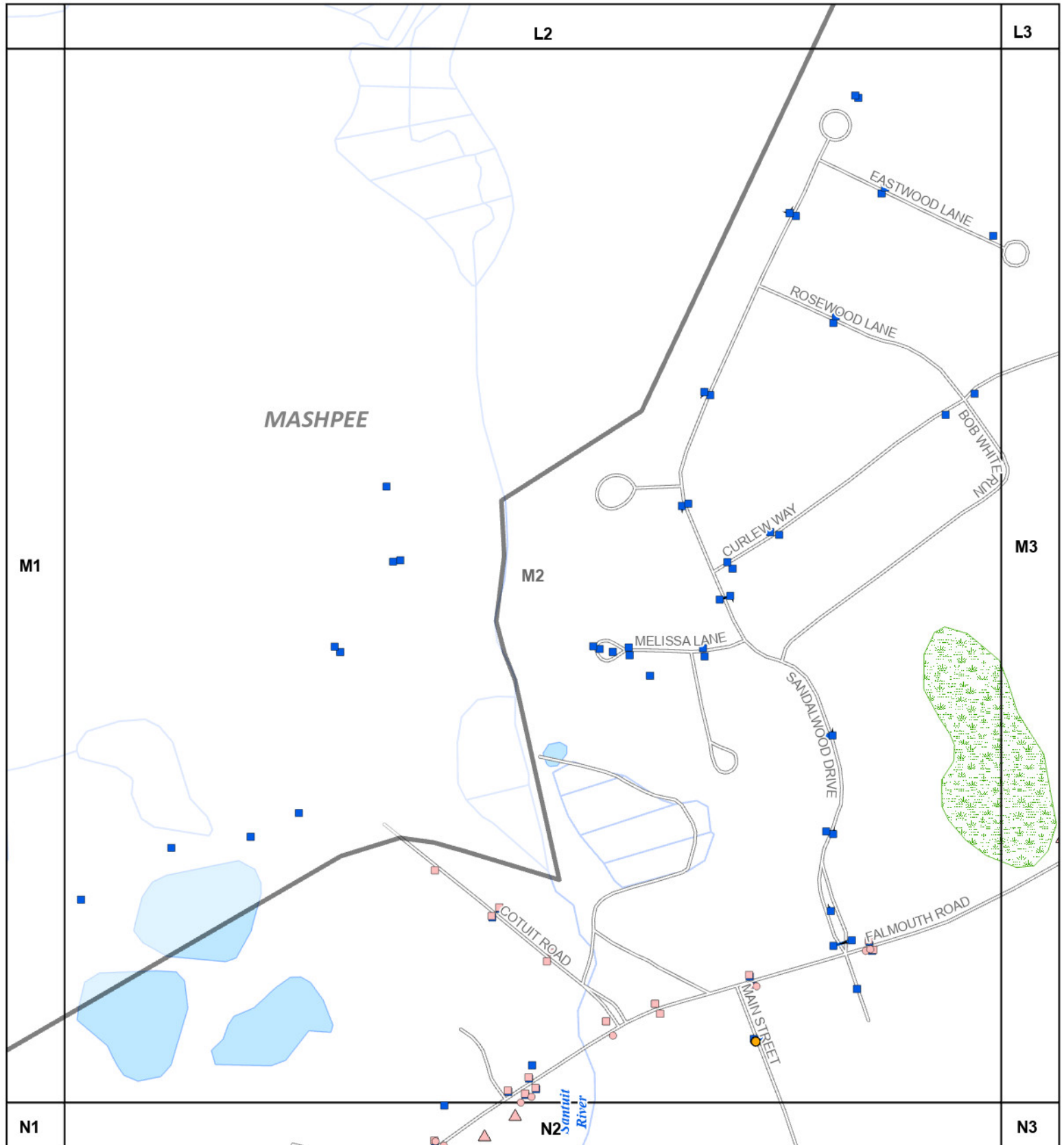
SHEET

M1

0 100 200 300 400 500
Feet



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Environmental
Incorporated



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| ▲ Outfalls | ● DOT Manhole |
| ■ Catch Basin | ■ DOT Catch Basin |
| ● Drainage Manhole | — Storm Water Gravity Drain |
| ■ Stormwater BMP | — Swale |
| ★ Key Drainage Manhole | — Catchment |
| ✚ Interconnections | — Non-Urban Area |
| ▲ DOT Outfall | |

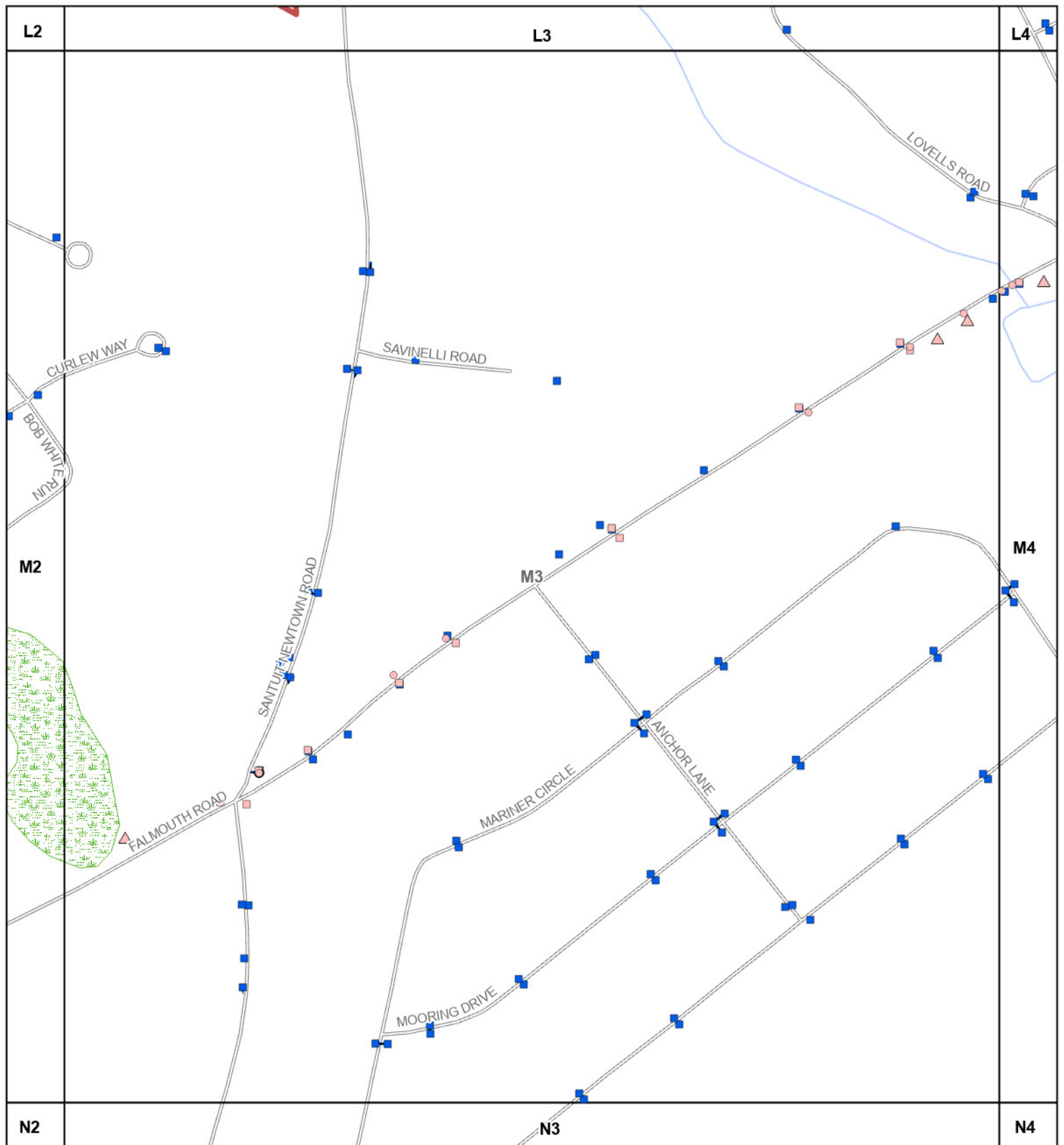
Stormwater Infrastructure Map Barnstable, MA

SHEET
M2

0 100 200 300 400 500
Feet



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Environmental
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| ▲ Outfalls | ● DOT Manhole |
| ■ Catch Basin | ■ DOT Catch Basin |
| ● Drainage Manhole | — Storm Water Gravity Drain |
| ■ Stormwater BMP | — Swale |
| ★ Key Drainage Manhole | — Catchment |
| ✚ Interconnections | — Non-Urban Area |
| ▲ DOT Outfall | |

Stormwater Infrastructure Map Barnstable, MA

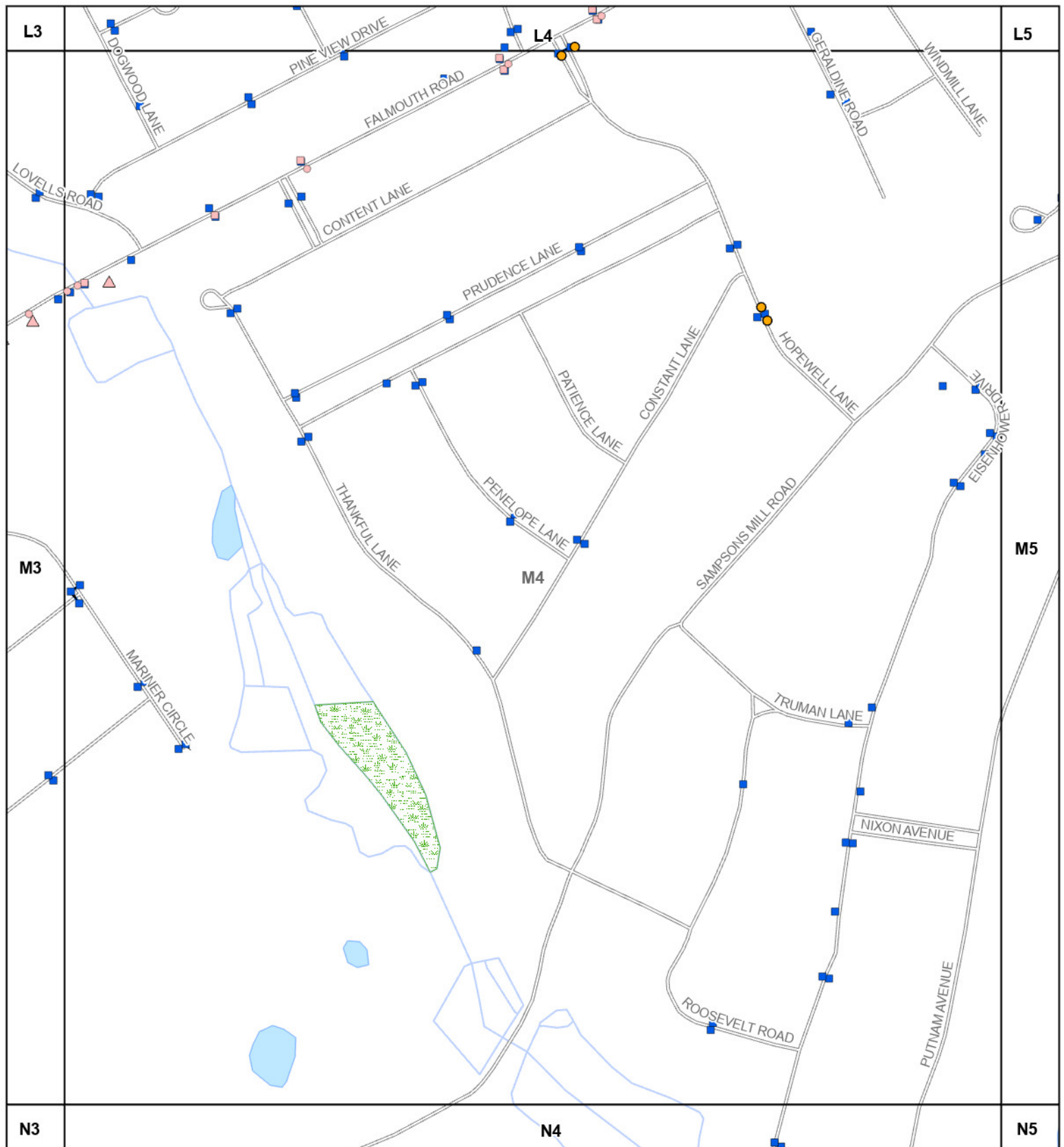
SHEET

M3

0 100 200 300 400 500
Feet



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Environmental
Incorporated



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| ▲ Outfalls | ● DOT Manhole |
| ■ Catch Basin | ■ DOT Catch Basin |
| ● Drainage Manhole | — Storm Water Gravity Drain |
| ■ Stormwater BMP | — Swale |
| ★ Key Drainage Manhole | — Catchment |
| ✚ Interconnections | — Non-Urban Area |
| ▲ DOT Outfall | |

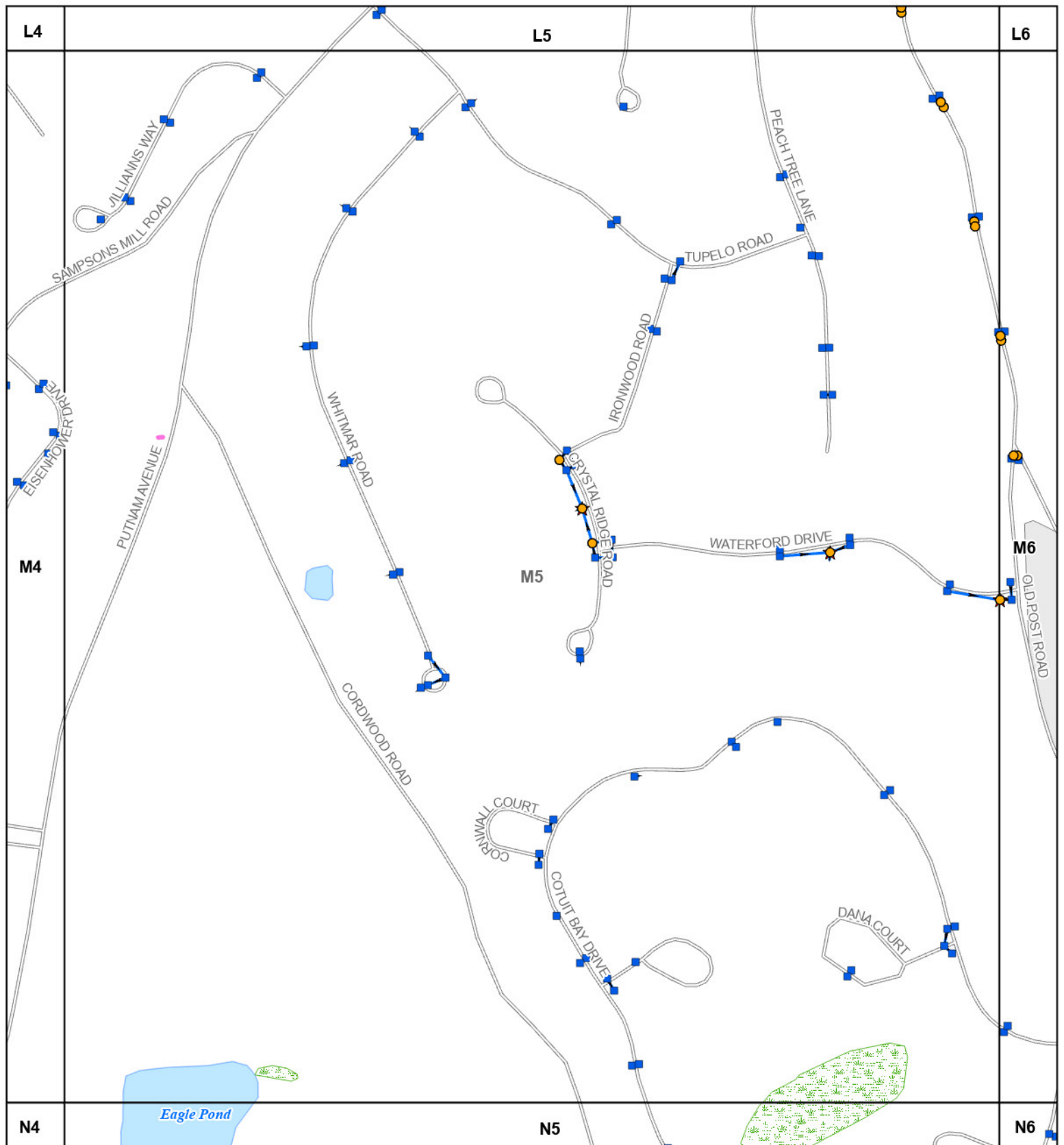
Stormwater Infrastructure Map Barnstable, MA

SHEET
M4

0 100 200 300 400 500
Feet



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| ▲ Outfalls | ○ DOT Manhole |
| ■ Catch Basin | ■ DOT Catch Basin |
| ● Drainage Manhole | — Storm Water Gravity Drain |
| ■ Stormwater BMP | — Swale |
| ★ Key Drainage Manhole | — Catchment |
| ✚ Interconnections | — Non-Urban Area |
| △ DOT Outfall | |

Stormwater Infrastructure Map Barnstable, MA

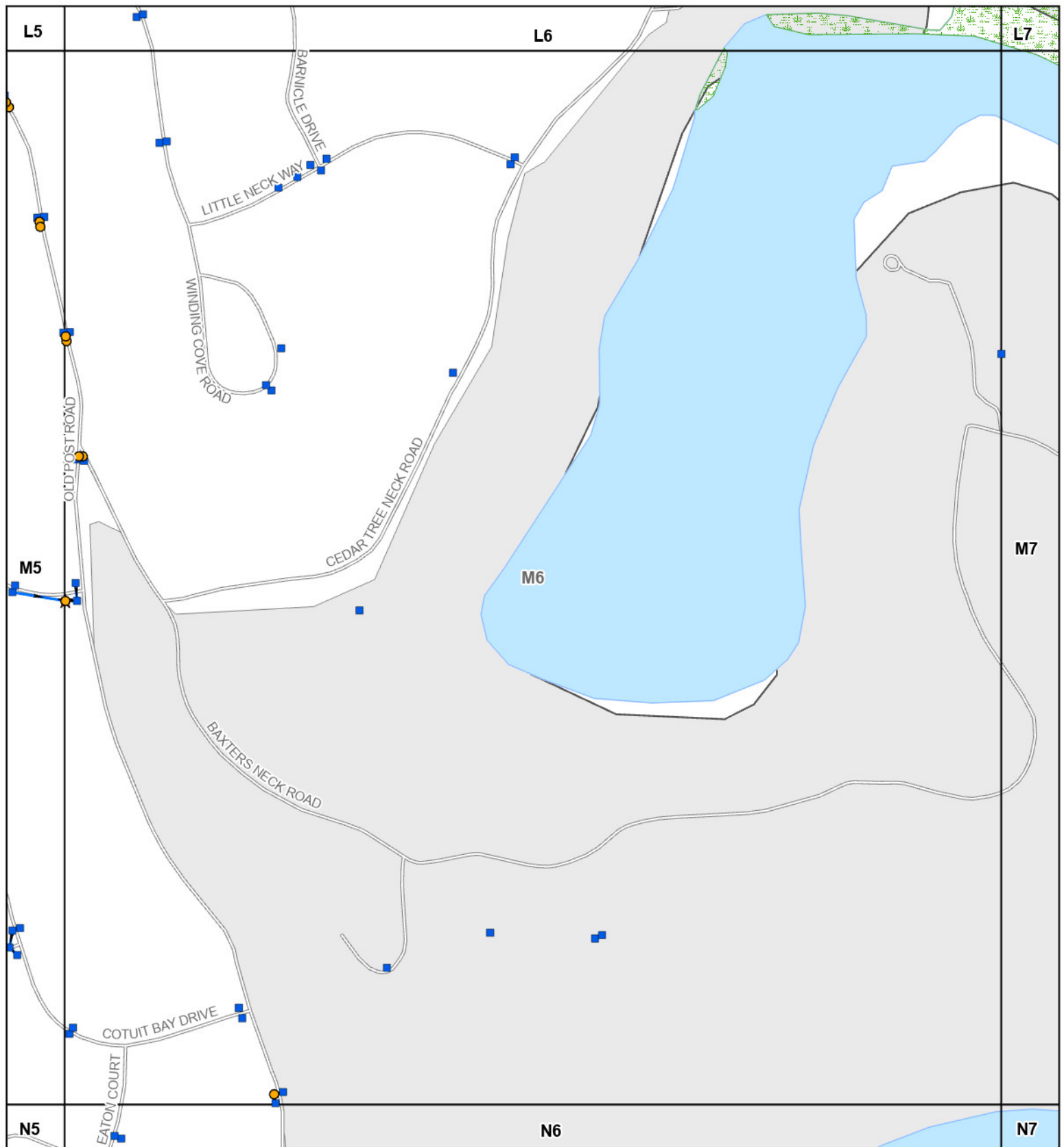
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M5

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Feet



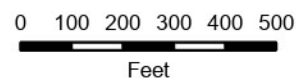
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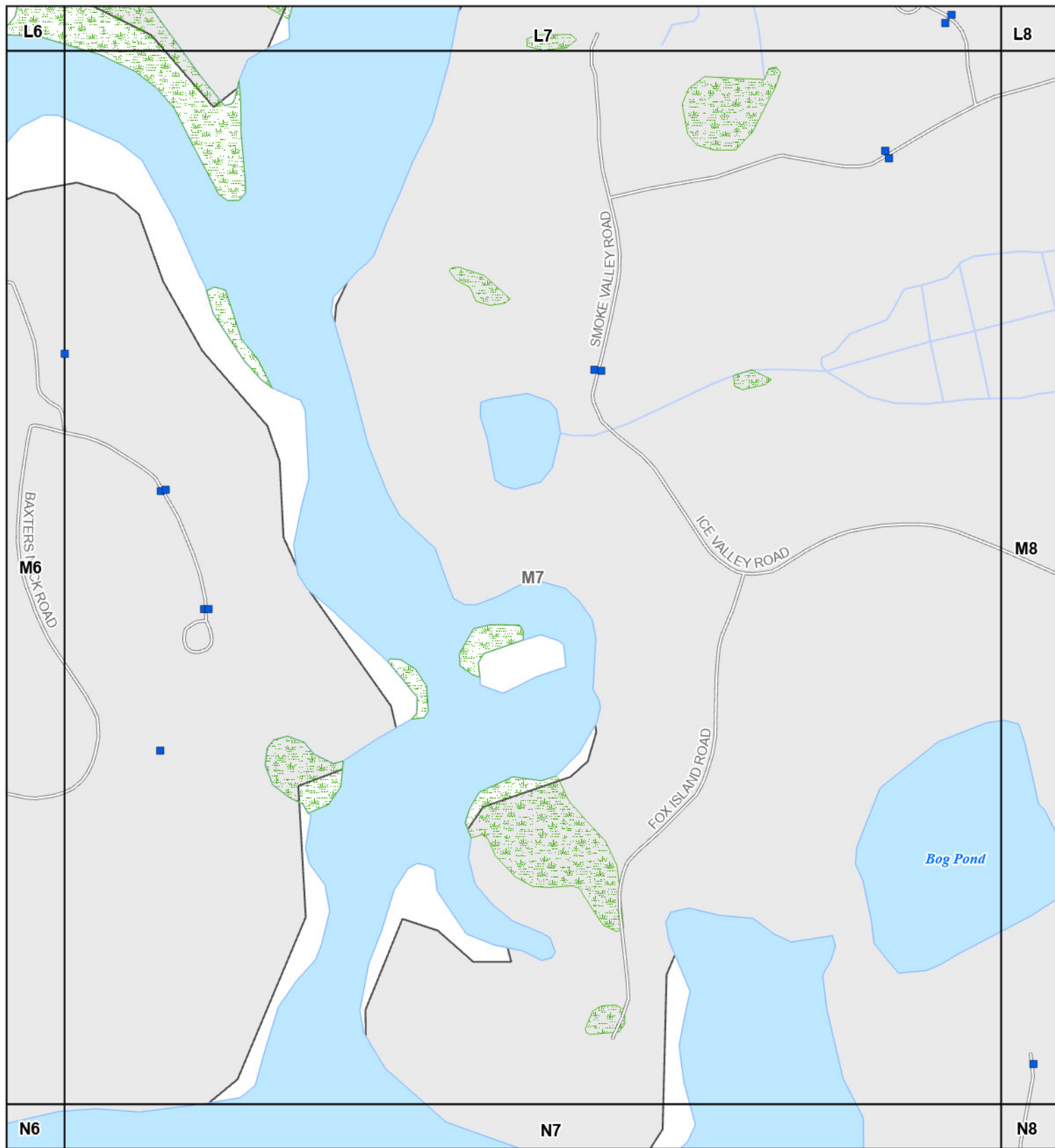
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| ▲ Outfalls | ○ DOT Manhole |
| ■ Catch Basin | ■ DOT Catch Basin |
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| ■ Stormwater BMP | — Swale |
| ★ Key Drainage Manhole | — Catchment |
| ✚ Interconnections | — Non-Urban Area |
| △ DOT Outfall | |

Stormwater Infrastructure **Map** **Barnstable, MA**

SHEET
M6



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| ▲ Outfalls | ● DOT Manhole |
| ■ Catch Basin | ■ DOT Catch Basin |
| ● Drainage Manhole | — Storm Water Gravity Drain |
| ■ Stormwater BMP | — Swale |
| ★ Key Drainage Manhole | — Catchment |
| ✚ Interconnections | — Non-Urban Area |
| ▲ DOT Outfall | |

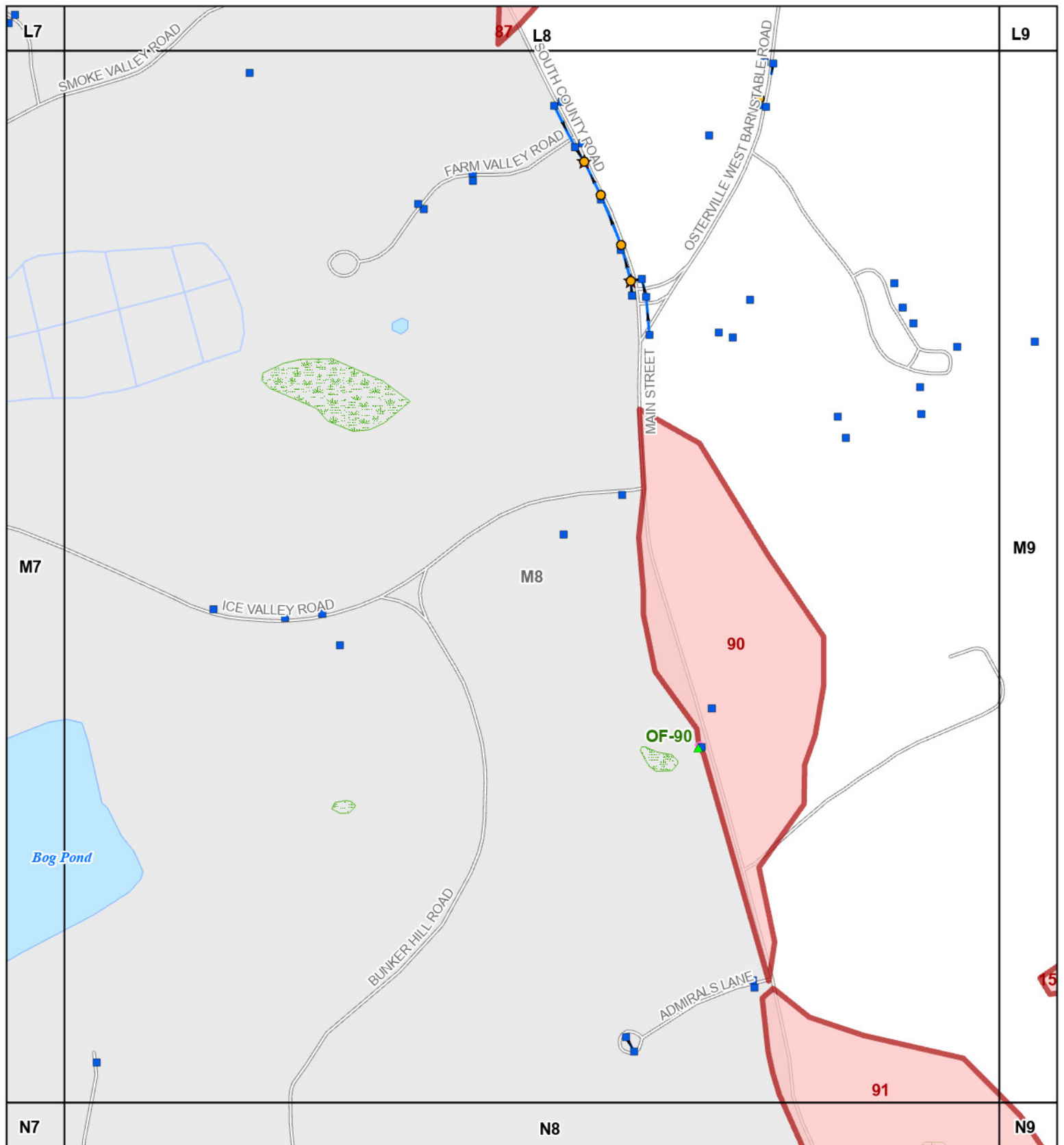
Stormwater Infrastructure Map Barnstable, MA

SHEET
M7

0 100 200 300 400 500
Feet



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| ▲ Outfalls | ○ DOT Manhole |
| ■ Catch Basin | ■ DOT Catch Basin |
| ● Drainage Manhole | — Storm Water Gravity Drain |
| ■ Stormwater BMP | — Swale |
| ★ Key Drainage Manhole | — Catchment |
| ✚ Interconnections | — Non-Urban Area |
| ▲ DOT Outfall | |

Stormwater Infrastructure Map Barnstable, MA

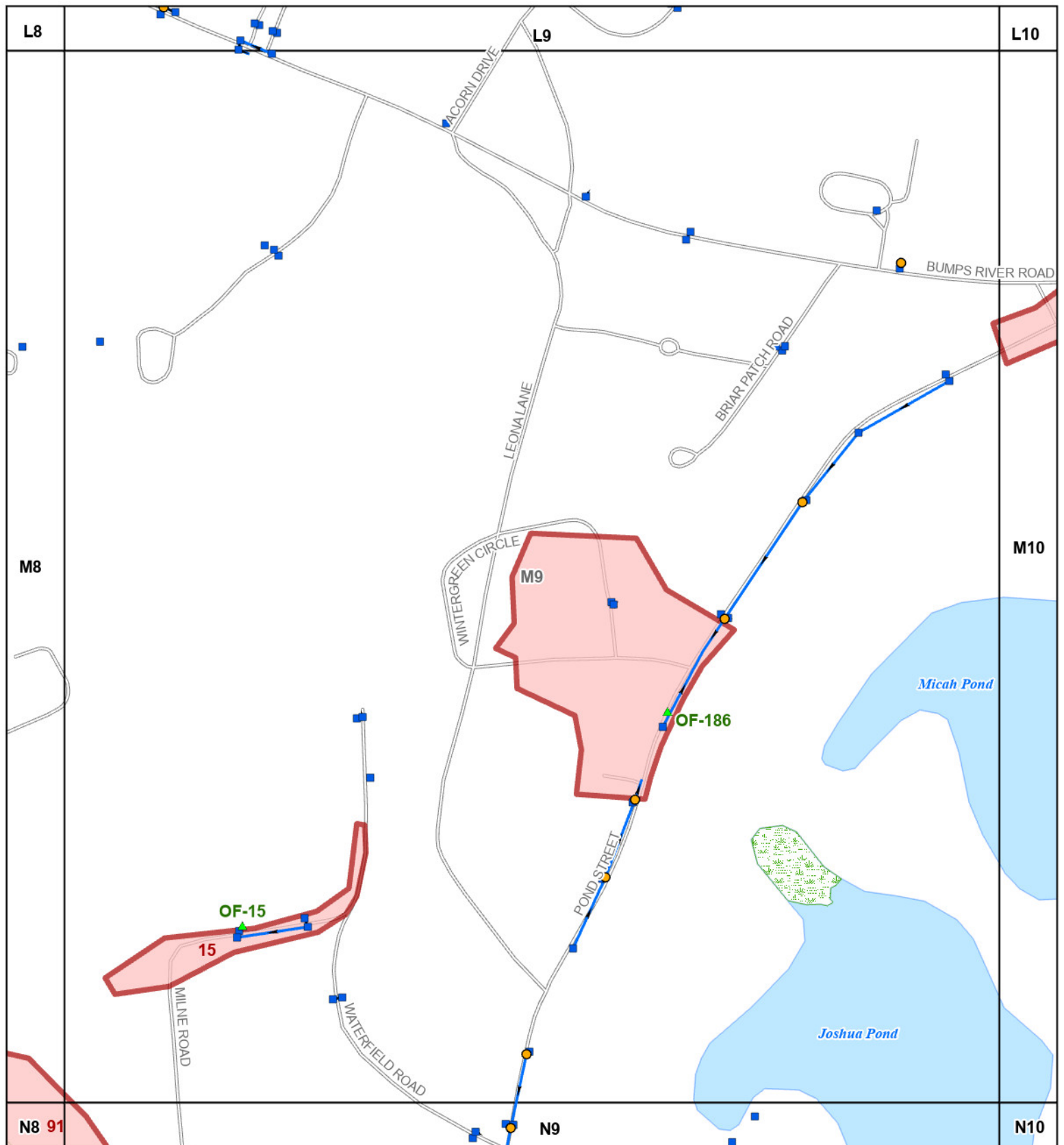
SHEET

M8

0 100 200 300 400 500
Feet



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Incorporated



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| ▲ Outfalls | ○ DOT Manhole |
| ■ Catch Basin | ■ DOT Catch Basin |
| ● Drainage Manhole | — Storm Water Gravity Drain |
| ■ Stormwater BMP | — Swale |
| ★ Key Drainage Manhole | — Catchment |
| ✚ Interconnections | — Non-Urban Area |
| ▲ DOT Outfall | |

Stormwater Infrastructure Map Barnstable, MA

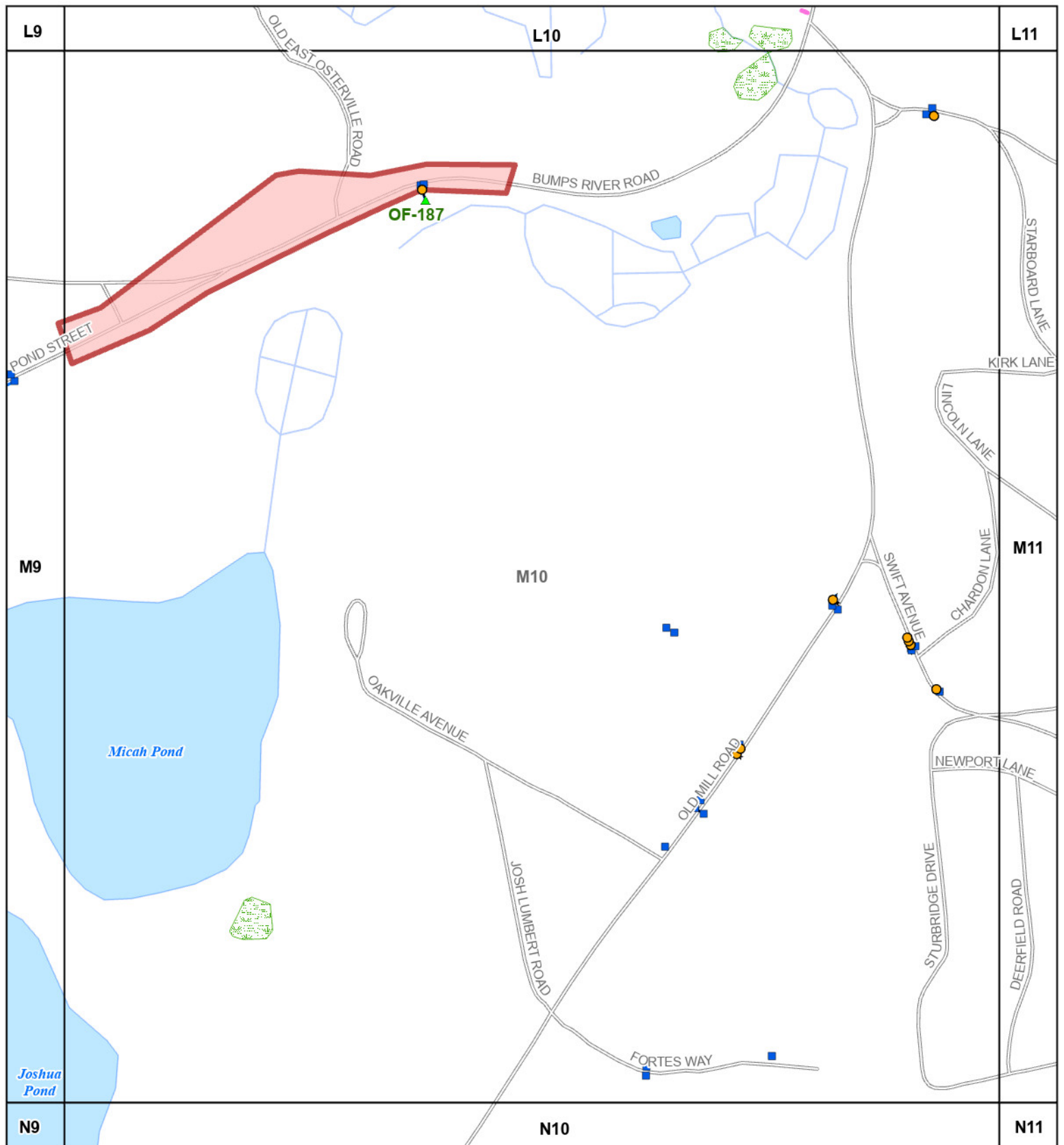
SHEET

M9

0 100 200 300 400 500
Feet



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| ■ Catch Basin | ■ DOT Catch Basin |
| ● Drainage Manhole | — Storm Water Gravity Drain |
| ■ Stormwater BMP | — Swale |
| ★ Key Drainage Manhole | — Catchment |
| ✚ Interconnections | — Non-Urban Area |
| ▲ DOT Outfall | |

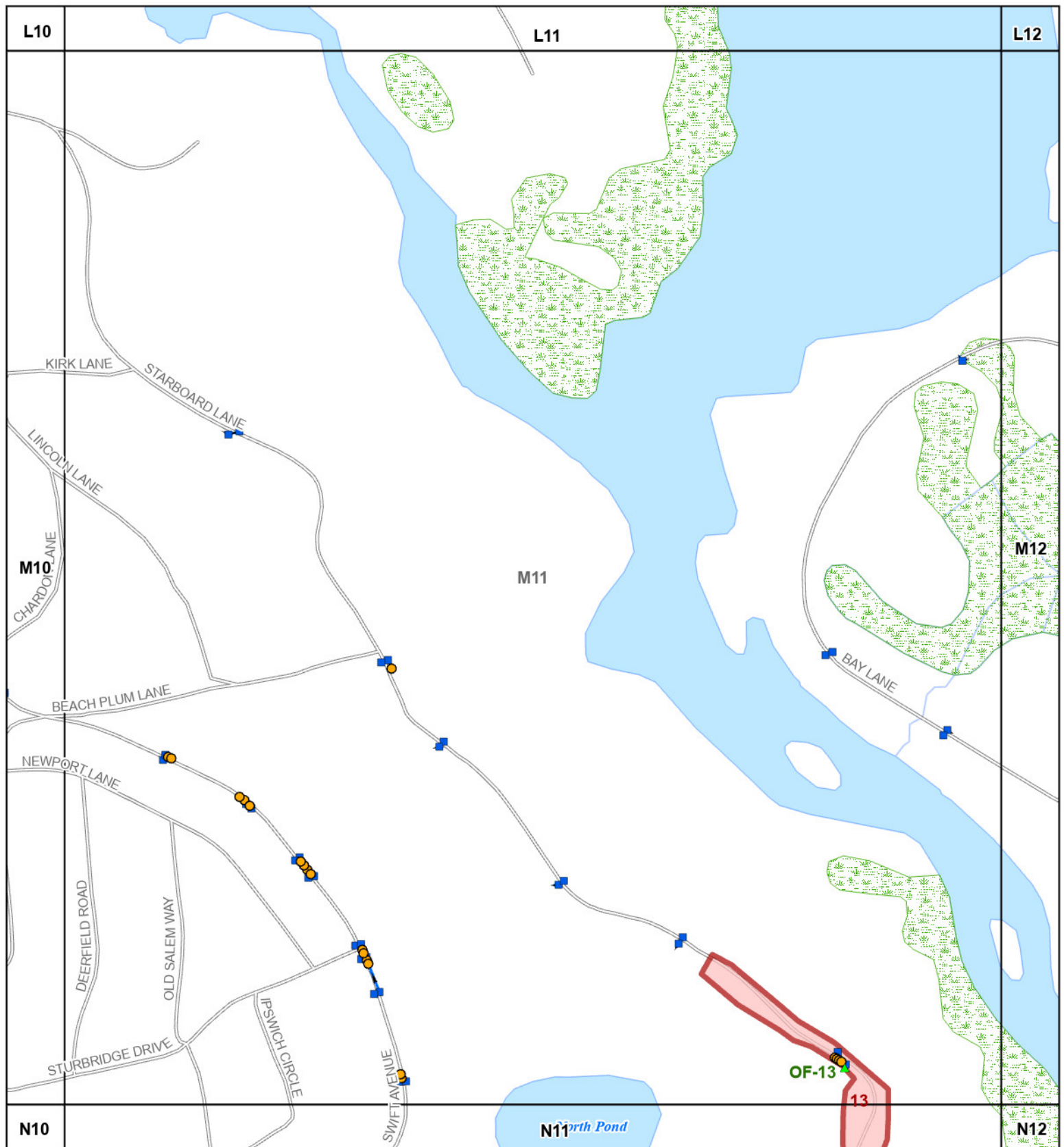
Stormwater Infrastructure Map Barnstable, MA

0 100 200 300 400 500
Feet

SHEET
M10



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| ▲ Outfalls | ○ DOT Manhole |
| ■ Catch Basin | ■ DOT Catch Basin |
| ● Drainage Manhole | — Storm Water Gravity Drain |
| ■ Stormwater BMP | ~ Swale |
| ★ Key Drainage Manhole | 👄 Catchment |
| ✚ Interconnections | ☁ Non-Urban Area |
| ▲ DOT Outfall | |

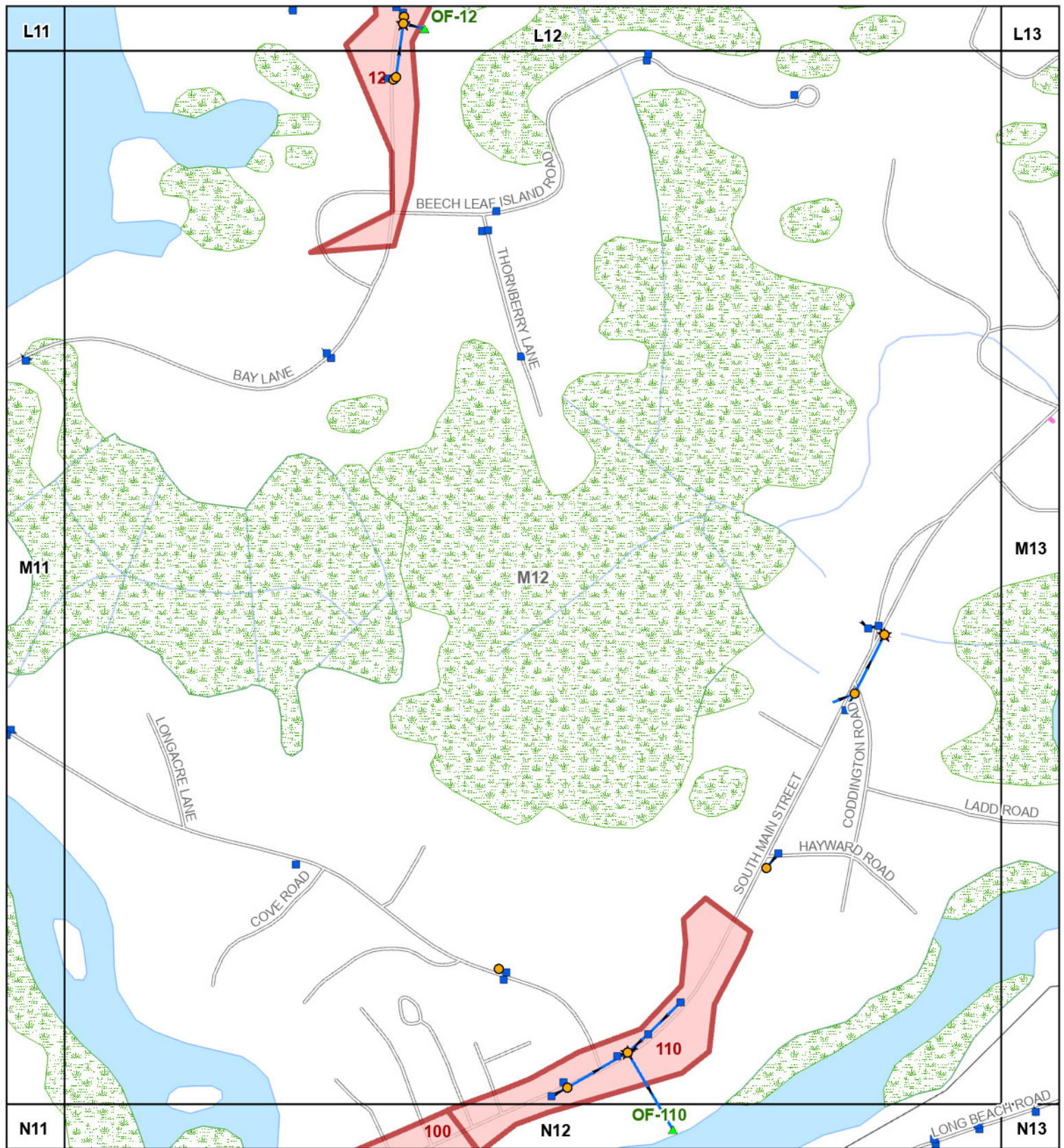
Stormwater Infrastructure Map Barnstable, MA

SHEET
M11

0 100 200 300 400 500
Feet



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| ▲ Outfalls | ○ DOT Manhole |
| ■ Catch Basin | ■ DOT Catch Basin |
| ● Drainage Manhole | — Storm Water Gravity Drain |
| ■ Stormwater BMP | — Swale |
| ★ Key Drainage Manhole | — Catchment |
| ✚ Interconnections | — Non-Urban Area |
| ▲ DOT Outfall | |

Stormwater Infrastructure Map Barnstable, MA

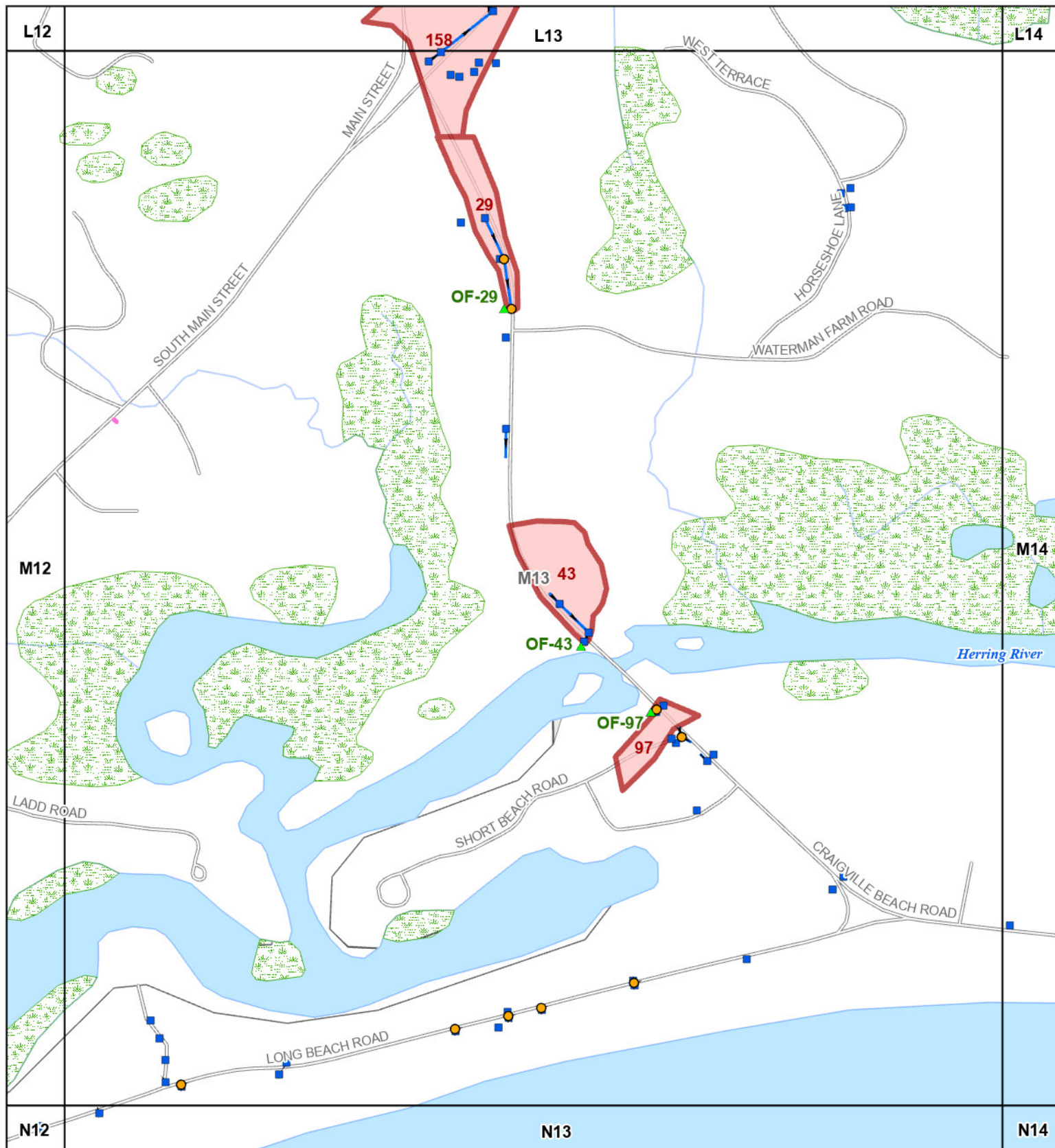
SHEET

M12

0 100 200 300 400 500
Feet



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| ■ Catch Basin | ■ DOT Catch Basin |
| ● Drainage Manhole | — Storm Water Gravity Drain |
| ■ Stormwater BMP | — Swale |
| ★ Key Drainage Manhole | — Catchment |
| ✚ Interconnections | — Non-Urban Area |
| ▲ DOT Outfall | |

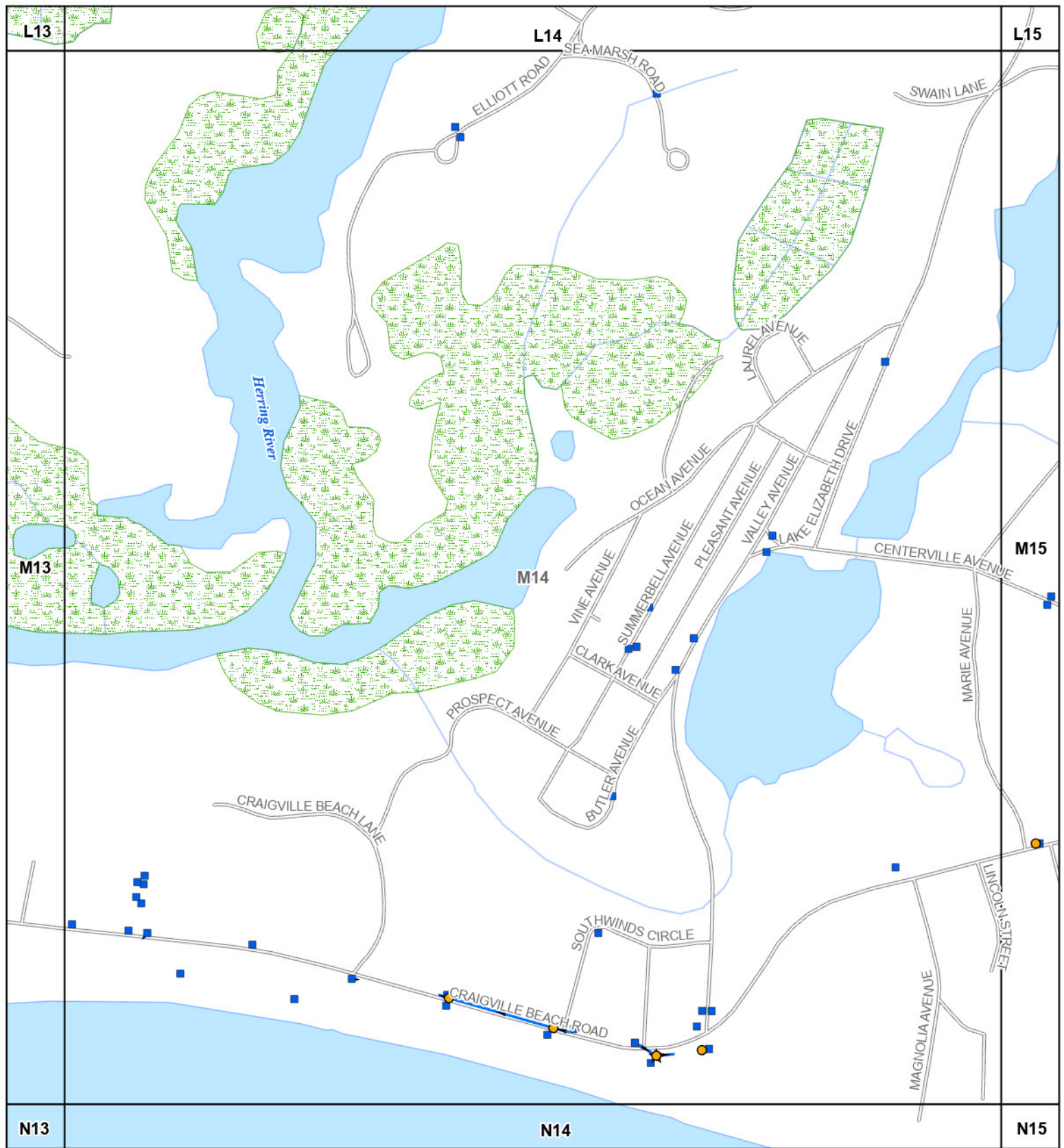
Stormwater Infrastructure Map Barnstable, MA

SHEET
M13

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Feet

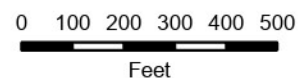


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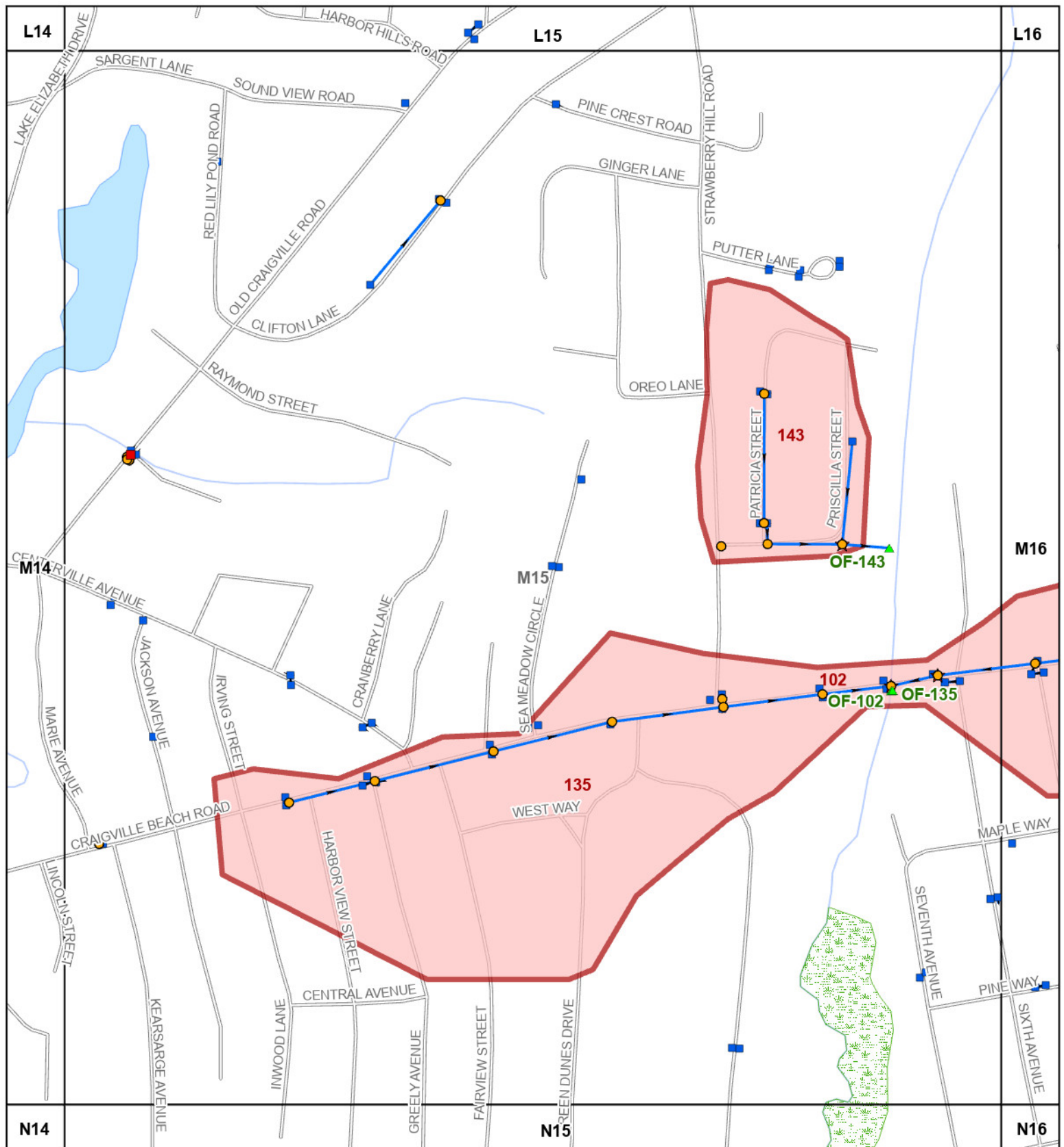


Stormwater Infrastructure Map Barnstable, MA

SHEET
M14



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| ■ Catch Basin | ■ DOT Catch Basin |
| ● Drainage Manhole | — Storm Water Gravity Drain |
| ■ Stormwater BMP | — Swale |
| ★ Key Drainage Manhole | — Catchment |
| ✚ Interconnections | — Non-Urban Area |
| ▲ DOT Outfall | |

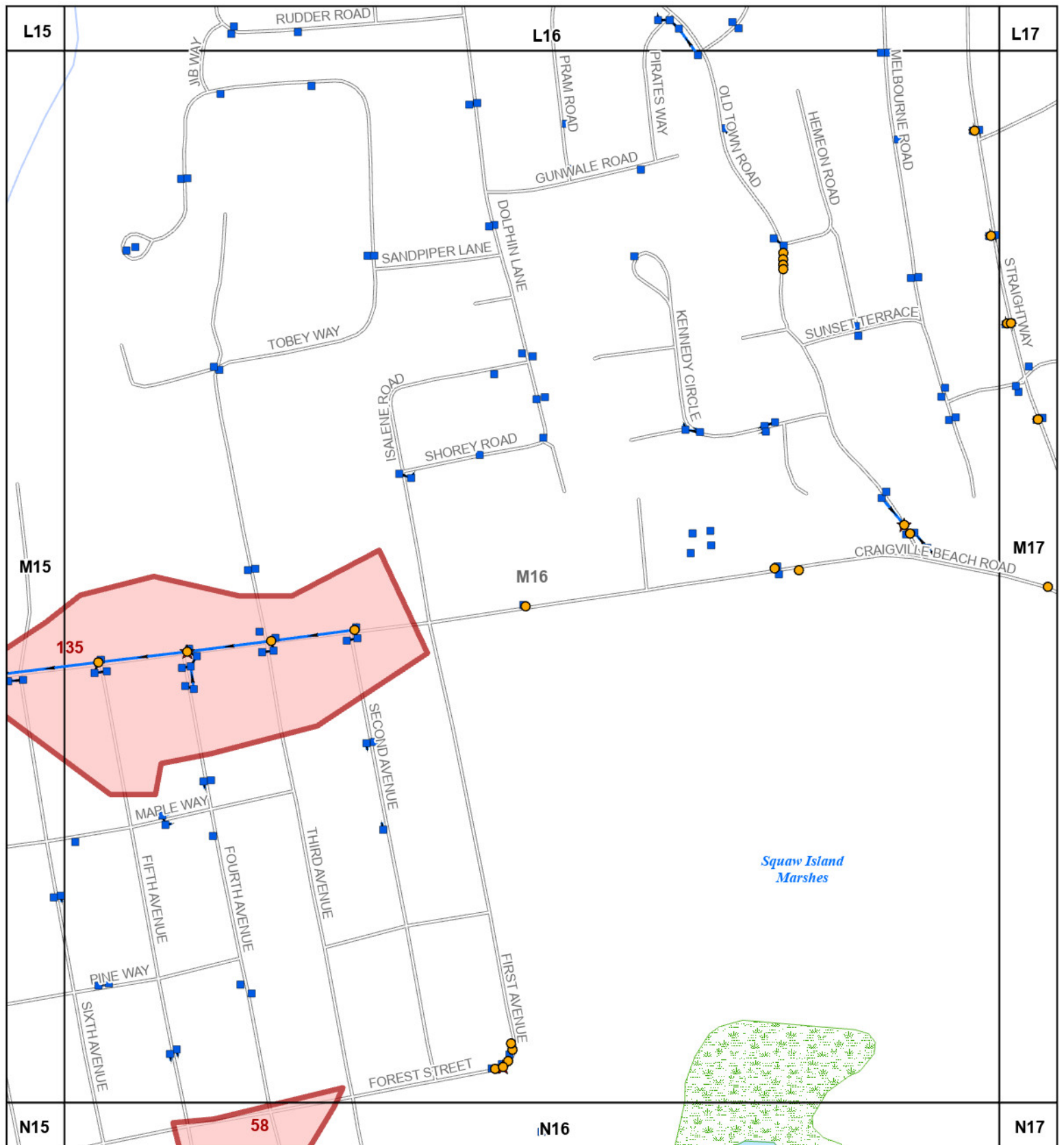
Stormwater Infrastructure Map Barnstable, MA

SHEET
M15

0 100 200 300 400 500
Feet



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| ▲ Outfalls | ○ DOT Manhole |
| ■ Catch Basin | ■ DOT Catch Basin |
| ● Drainage Manhole | — Storm Water Gravity Drain |
| ■ Stormwater BMP | — Swale |
| ★ Key Drainage Manhole | — Catchment |
| ✚ Interconnections | — Non-Urban Area |
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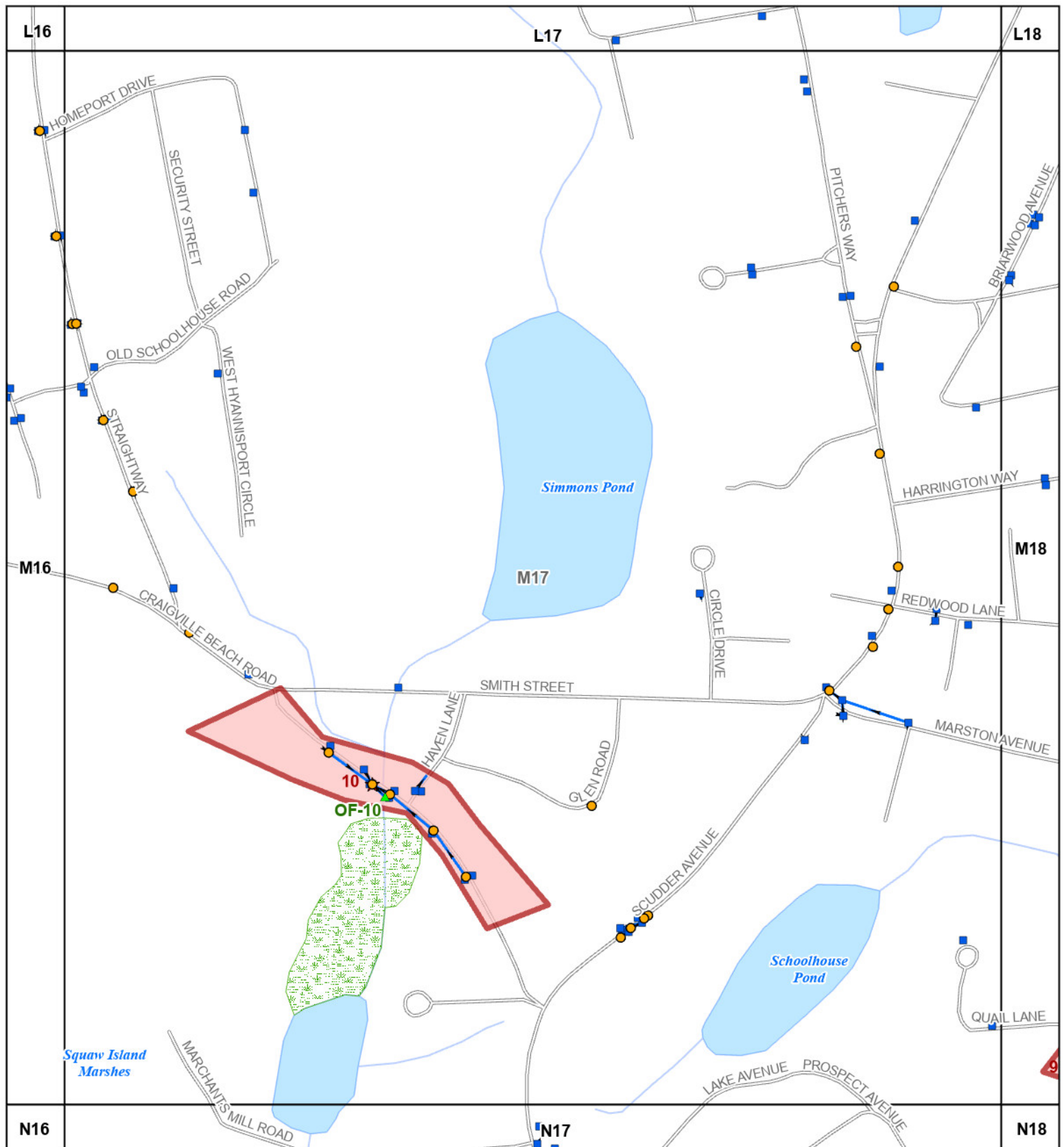
Stormwater Infrastructure Map Barnstable, MA

SHEET
M16

0 100 200 300 400 500
Feet



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| ■ Catch Basin | ■ DOT Catch Basin |
| ● Drainage Manhole | — Storm Water Gravity Drain |
| ■ Stormwater BMP | — Swale |
| ★ Key Drainage Manhole | — Catchment |
| ✚ Interconnections | — Non-Urban Area |
| △ DOT Outfall | |

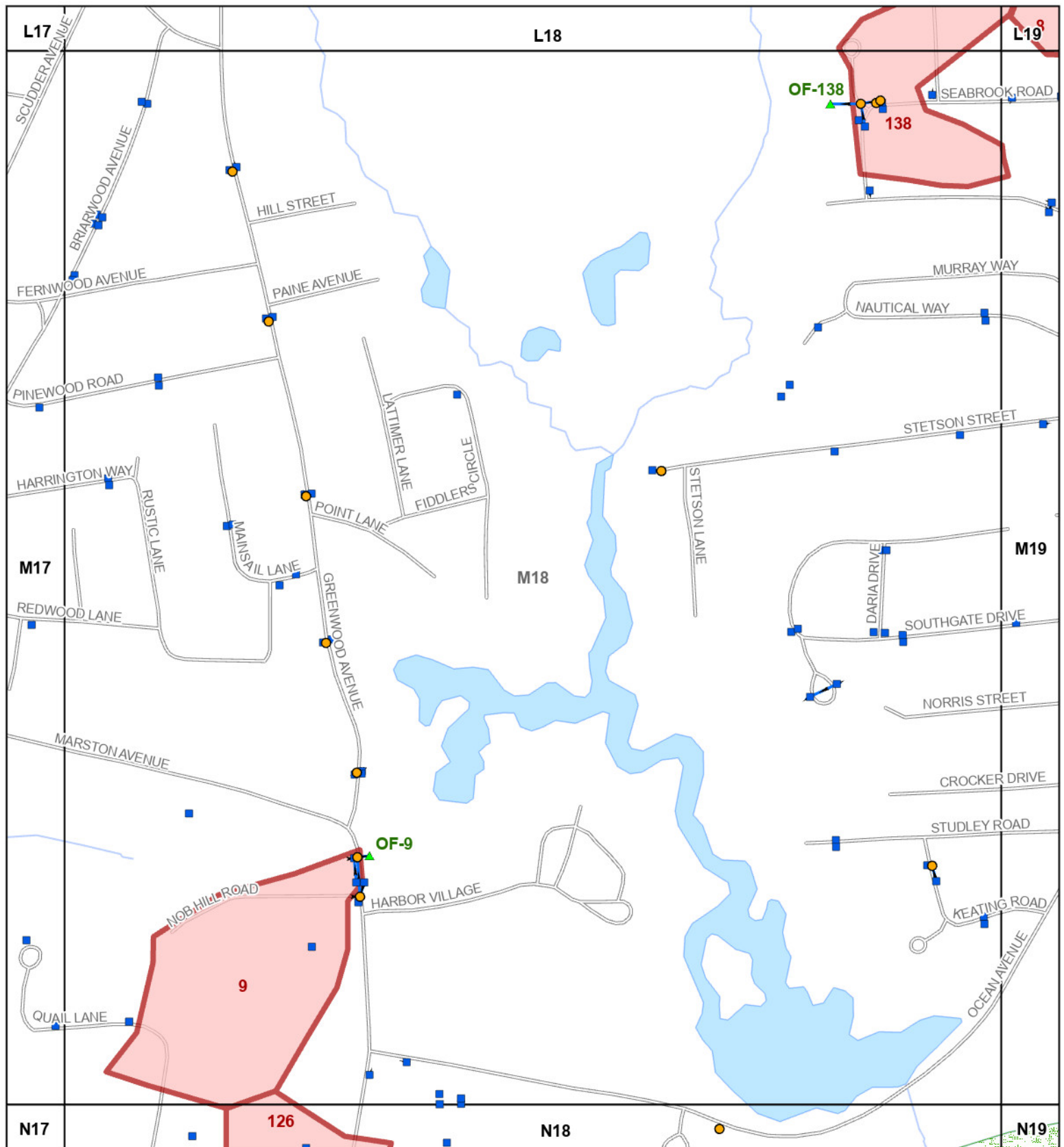
Stormwater Infrastructure Map Barnstable, MA

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| ▲ Outfalls | ○ DOT Manhole |
| ■ Catch Basin | ■ DOT Catch Basin |
| ● Drainage Manhole | — Storm Water Gravity Drain |
| ■ Stormwater BMP | — Swale |
| ★ Key Drainage Manhole | — Catchment |
| ✚ Interconnections | — Non-Urban Area |
| ▲ DOT Outfall | |

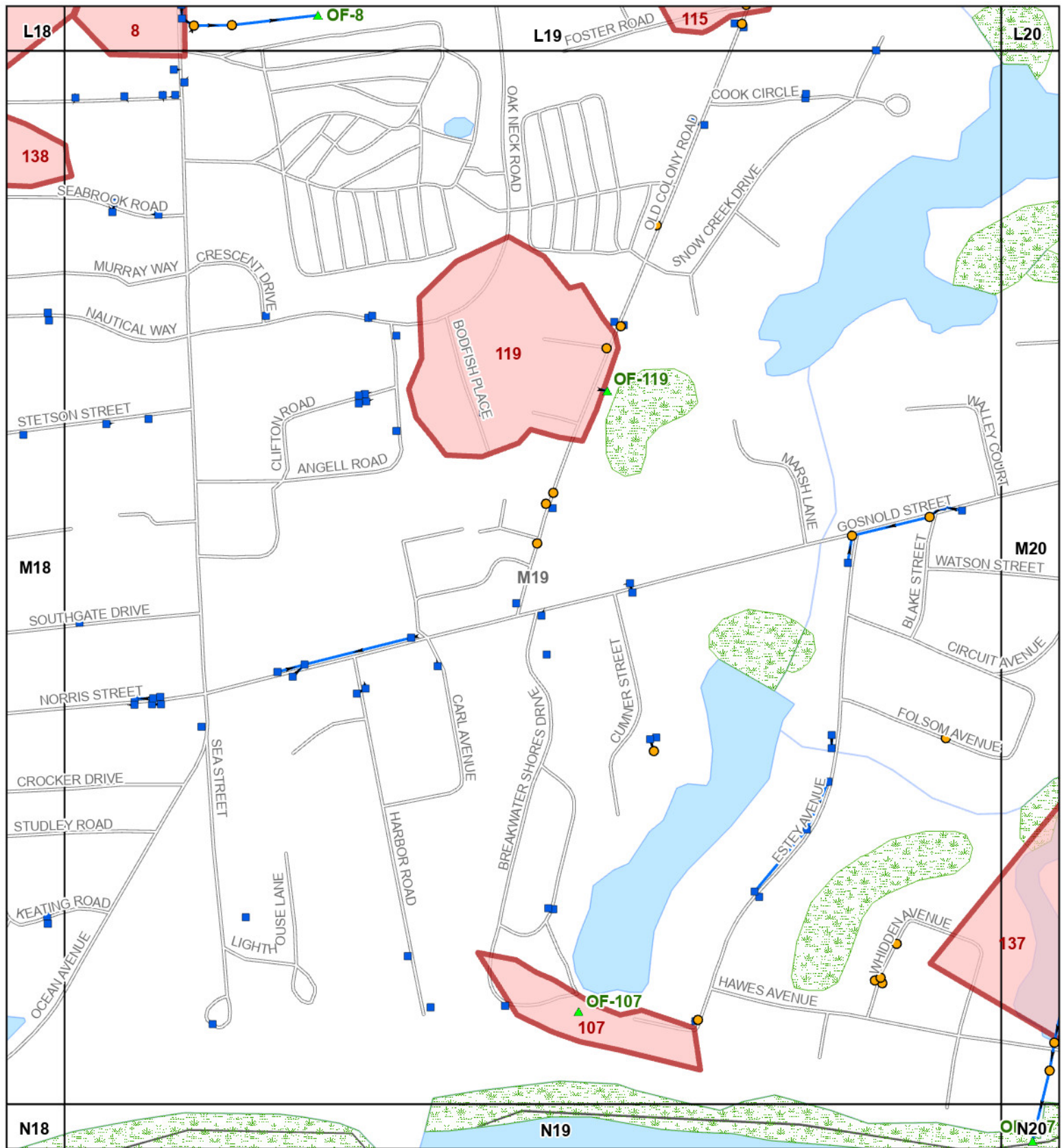
Stormwater Infrastructure Map Barnstable, MA

SHEET
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Feet



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| ▲ Outfalls | ● DOT Manhole |
| ■ Catch Basin | ■ DOT Catch Basin |
| ● Drainage Manhole | — Storm Water Gravity Drain |
| ■ Stormwater BMP | — Swale |
| ★ Key Drainage Manhole | — Catchment |
| ✚ Interconnections | — Non-Urban Area |
| ▲ DOT Outfall | |

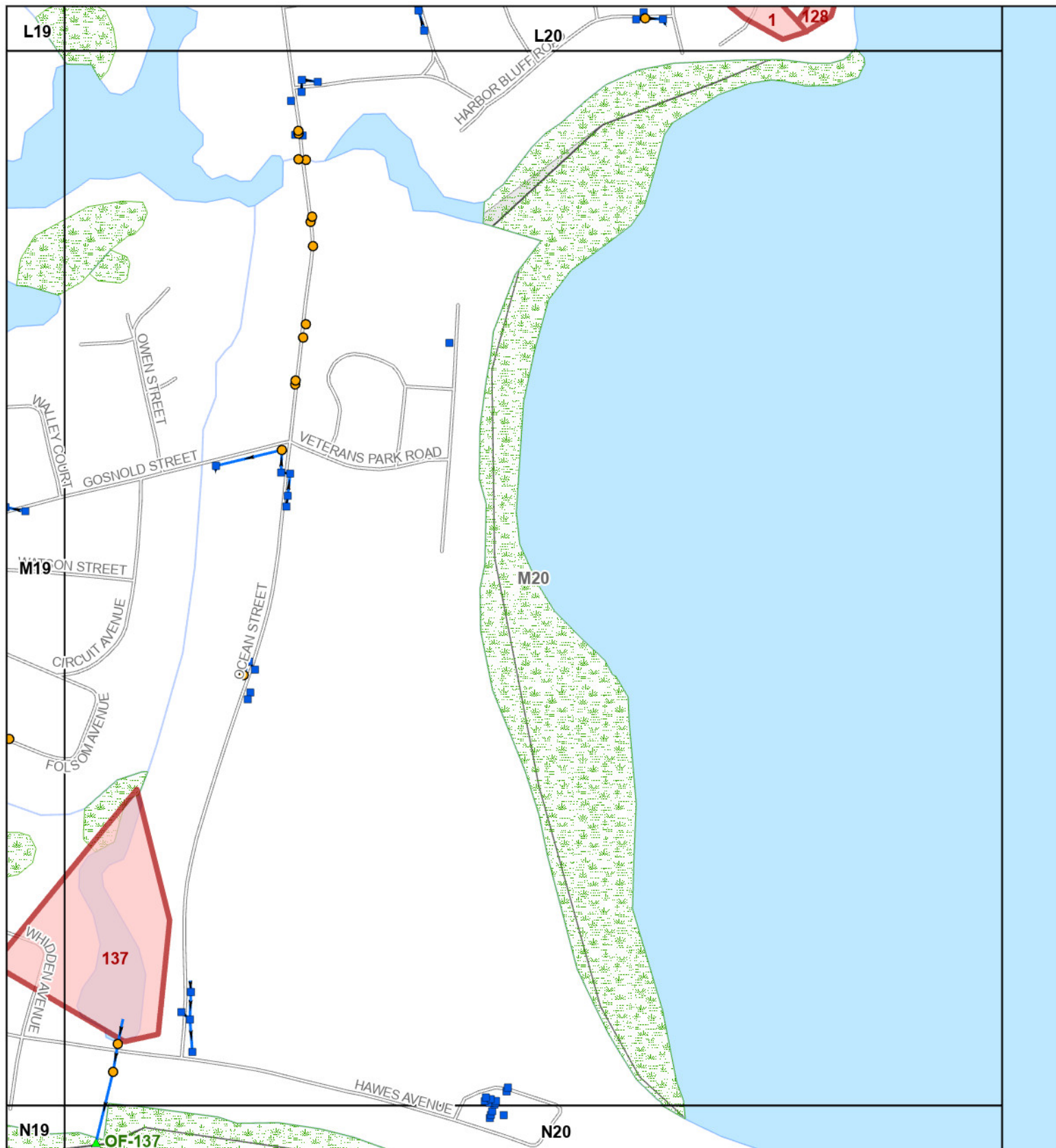
Stormwater Infrastructure Map Barnstable, MA

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M19

0 100 200 300 400 500
Feet

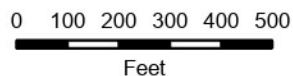


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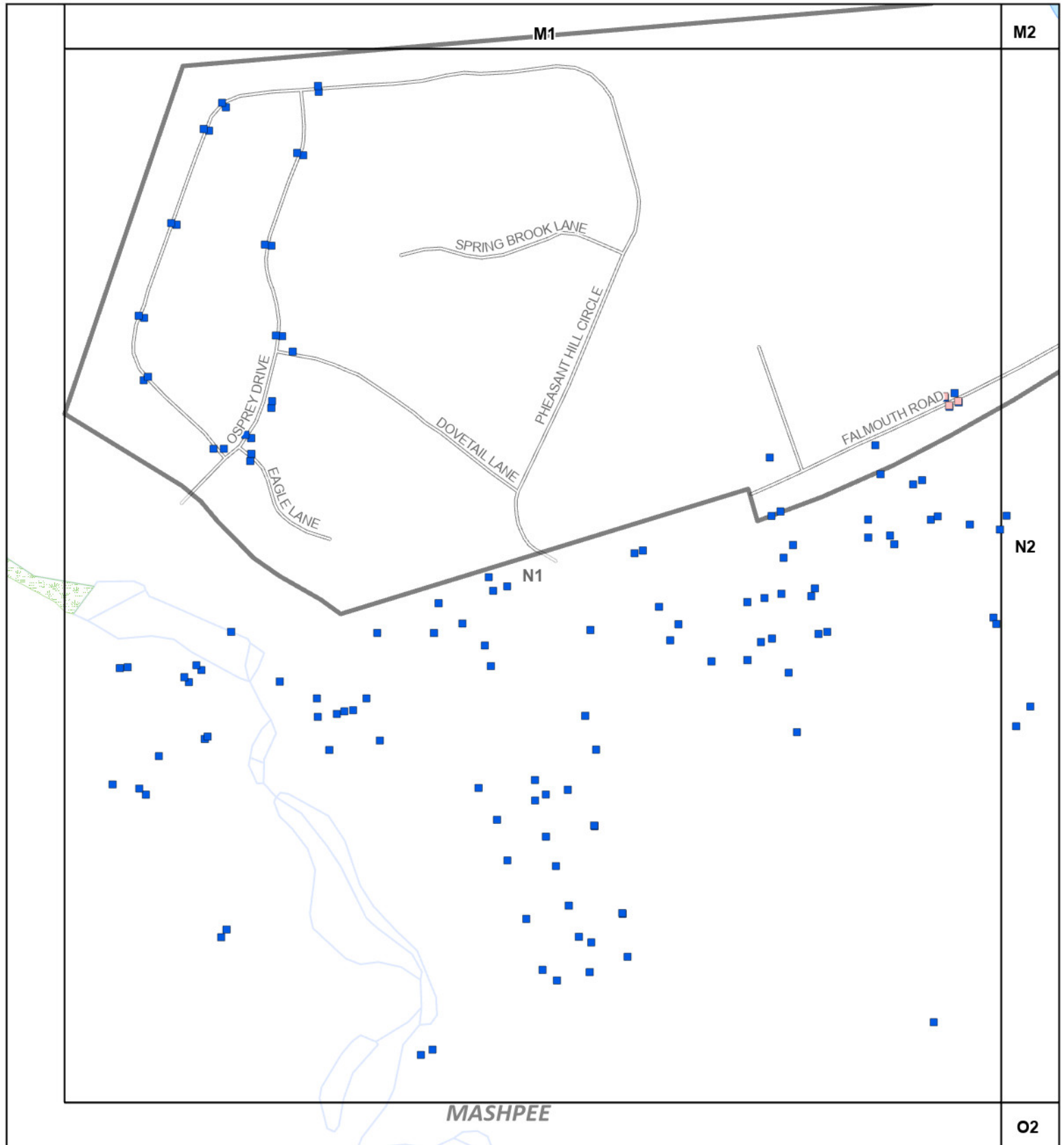


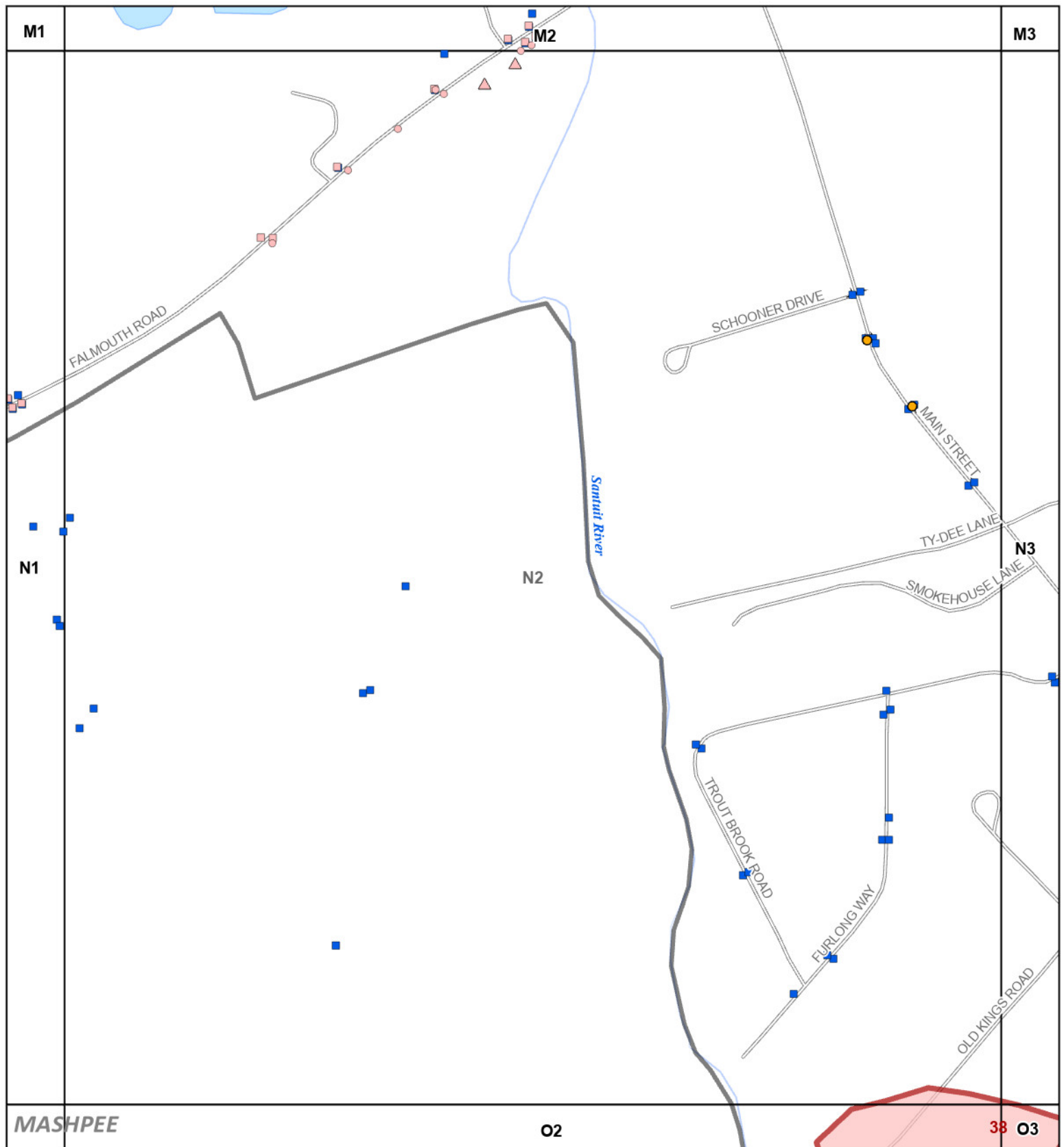
Stormwater Infrastructure Map Barnstable, MA

SHEET
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| ▲ Outfalls | ○ DOT Manhole |
| ■ Catch Basin | ■ DOT Catch Basin |
| ● Drainage Manhole | — Storm Water Gravity Drain |
| ■ Stormwater BMP | — Swale |
| ★ Key Drainage Manhole | — Catchment |
| ✚ Interconnections | — Non-Urban Area |
| ▲ DOT Outfall | |

Stormwater Infrastructure Map Barnstable, MA

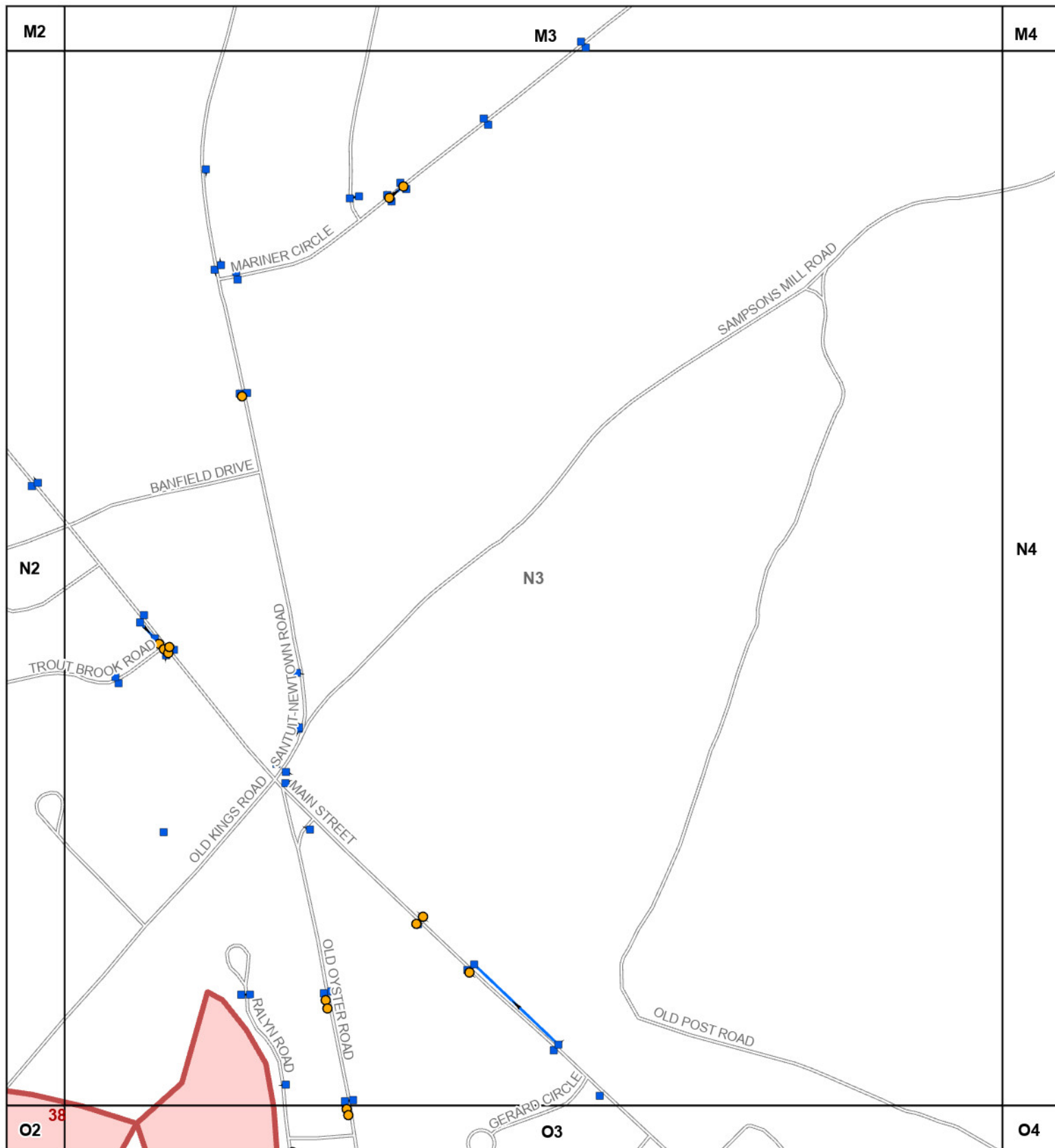
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Feet



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| ▲ Outfalls | ● DOT Manhole |
| ■ Catch Basin | ■ DOT Catch Basin |
| ● Drainage Manhole | — Storm Water Gravity Drain |
| ■ Stormwater BMP | — Swale |
| ★ Key Drainage Manhole | — Catchment |
| ✚ Interconnections | — Non-Urban Area |
| ▲ DOT Outfall | |

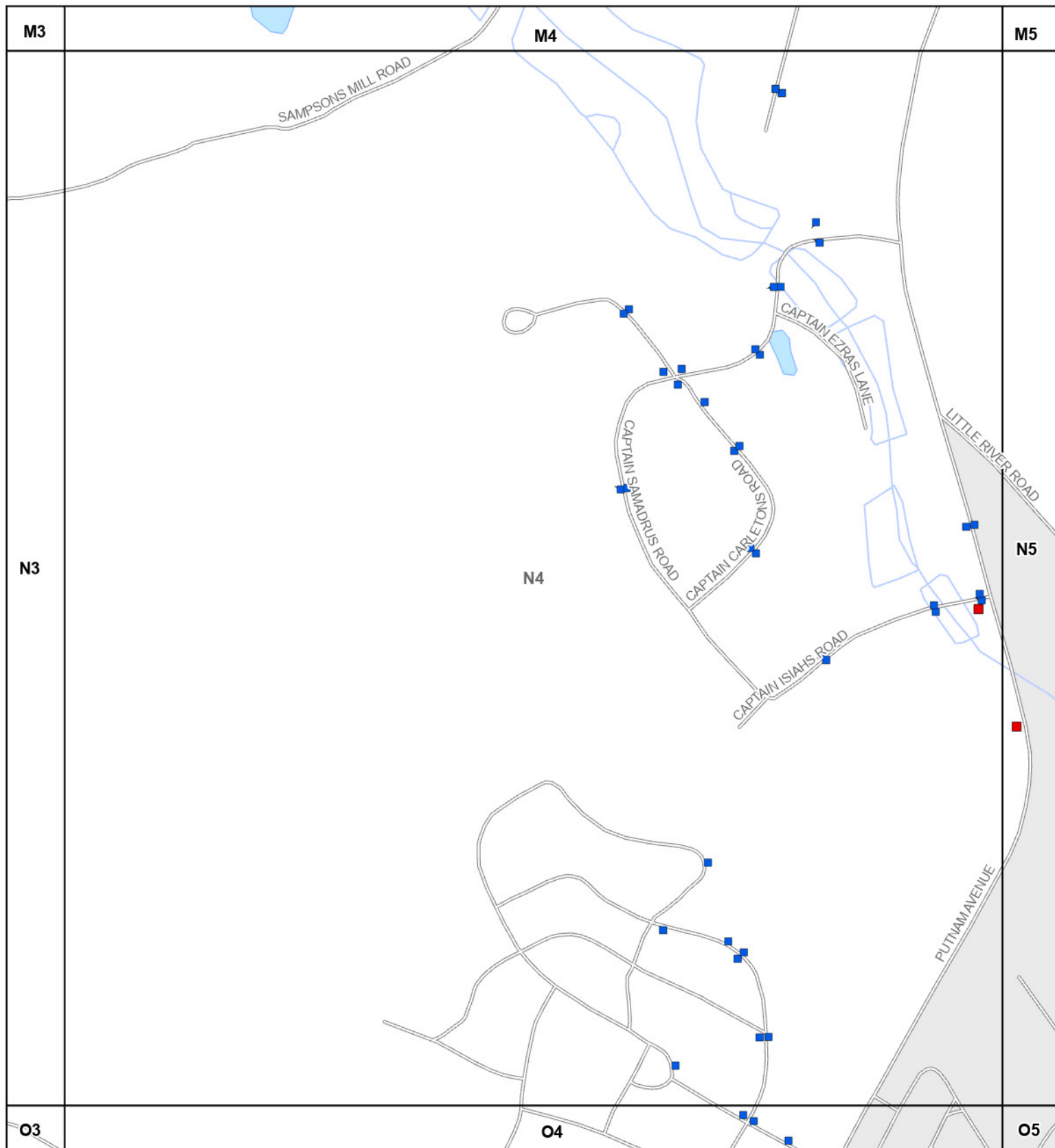
Stormwater Infrastructure Map Barnstable, MA

SHEET
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Feet



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| ■ Catch Basin | ■ DOT Catch Basin |
| ● Drainage Manhole | — Storm Water Gravity Drain |
| ■ Stormwater BMP | — Swale |
| ★ Key Drainage Manhole | — Catchment |
| ✚ Interconnections | — Non-Urban Area |
| △ DOT Outfall | |

Stormwater Infrastructure Map Barnstable, MA

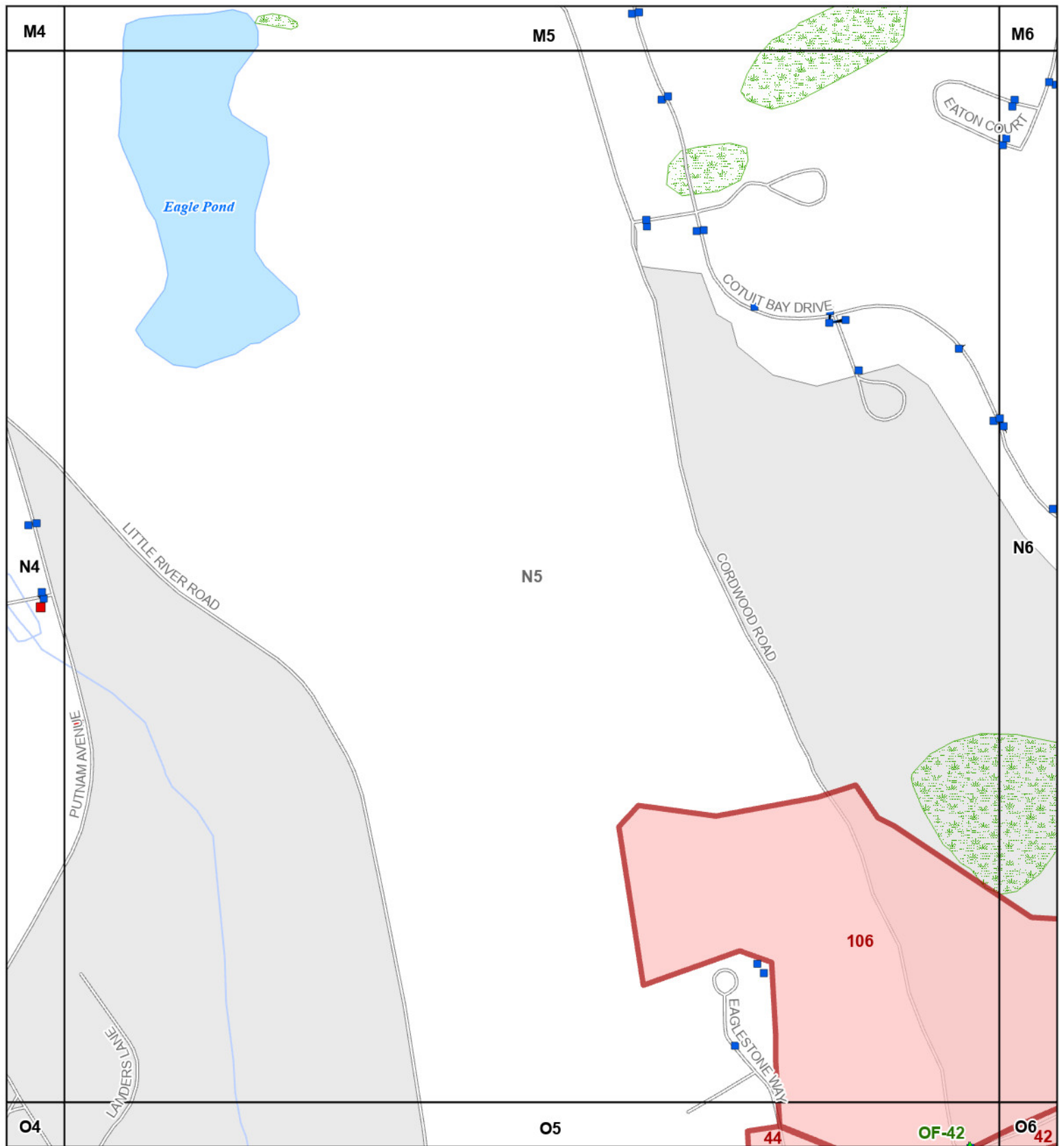
SHEET

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Feet



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| ■ Catch Basin | ■ DOT Catch Basin |
| ● Drainage Manhole | — Storm Water Gravity Drain |
| ■ Stormwater BMP | — Swale |
| ★ Key Drainage Manhole | — Catchment |
| ✚ Interconnections | — Non-Urban Area |
| ▲ DOT Outfall | |

Stormwater Infrastructure Map Barnstable, MA

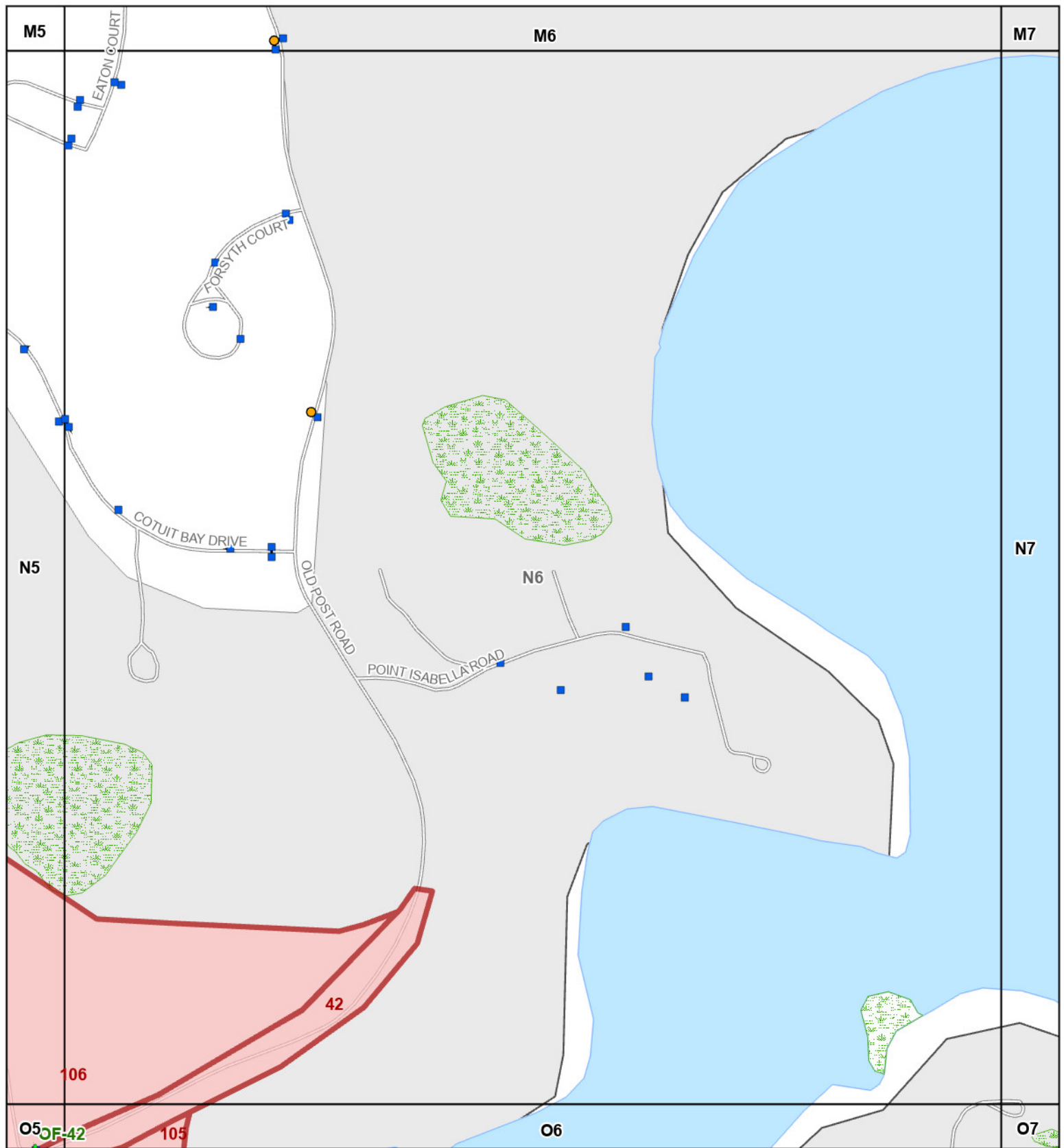
SHEET

N5

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Feet



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Environmental
Incorporated



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| ▲ Outfalls | ● DOT Manhole |
| ■ Catch Basin | ■ DOT Catch Basin |
| ● Drainage Manhole | — Storm Water Gravity Drain |
| ■ Stormwater BMP | — Swale |
| ★ Key Drainage Manhole | — Catchment |
| ✚ Interconnections | — Non-Urban Area |
| ▲ DOT Outfall | |

Stormwater Infrastructure Map Barnstable, MA

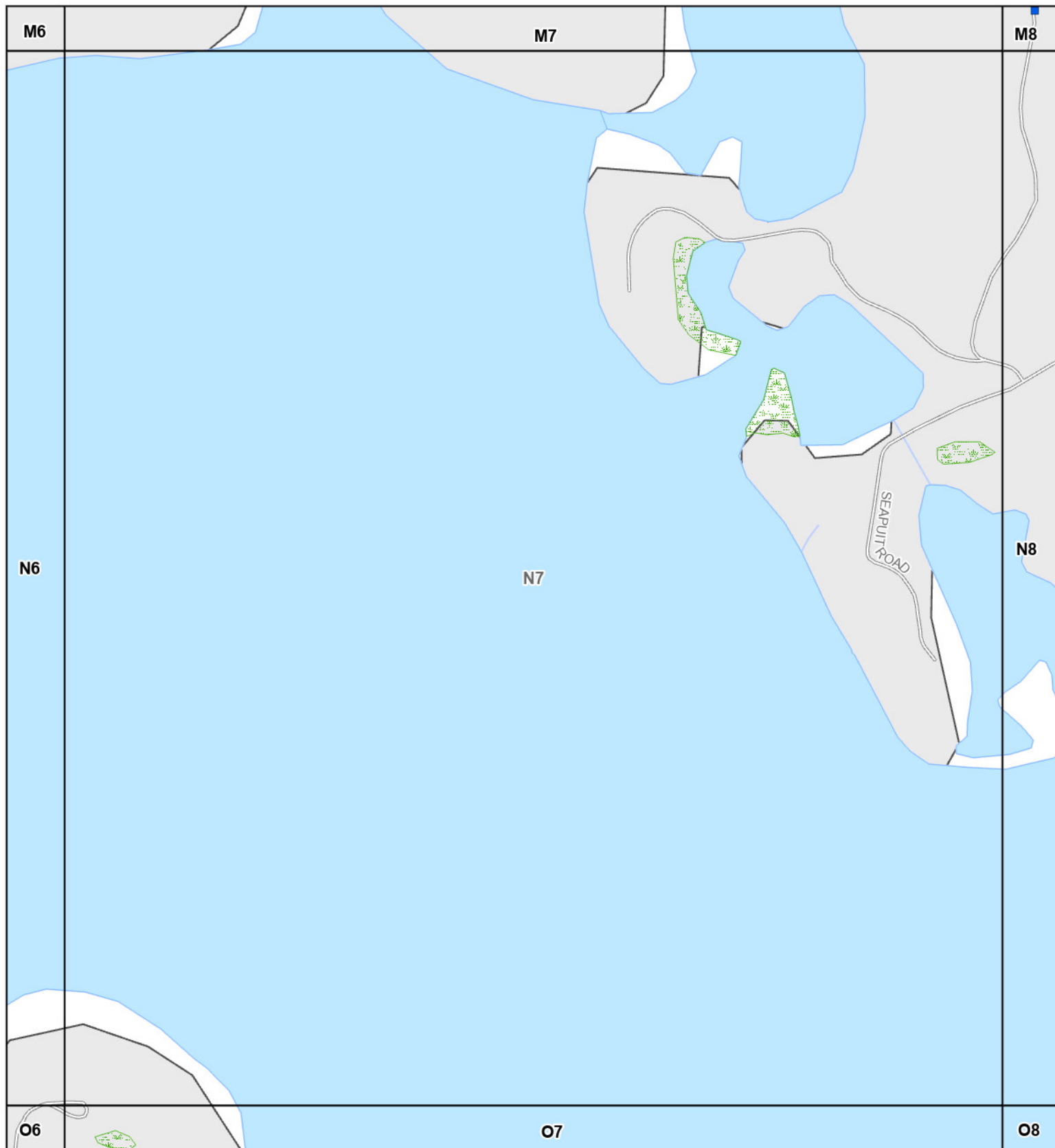
SHEET

N6

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Feet



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| ▲ Outfalls | ● DOT Manhole |
| ■ Catch Basin | ■ DOT Catch Basin |
| ● Drainage Manhole | — Storm Water Gravity Drain |
| ■ Stormwater BMP | — Swale |
| ★ Key Drainage Manhole | — Catchment |
| ✚ Interconnections | — Non-Urban Area |
| ▲ DOT Outfall | |

Stormwater Infrastructure Map Barnstable, MA

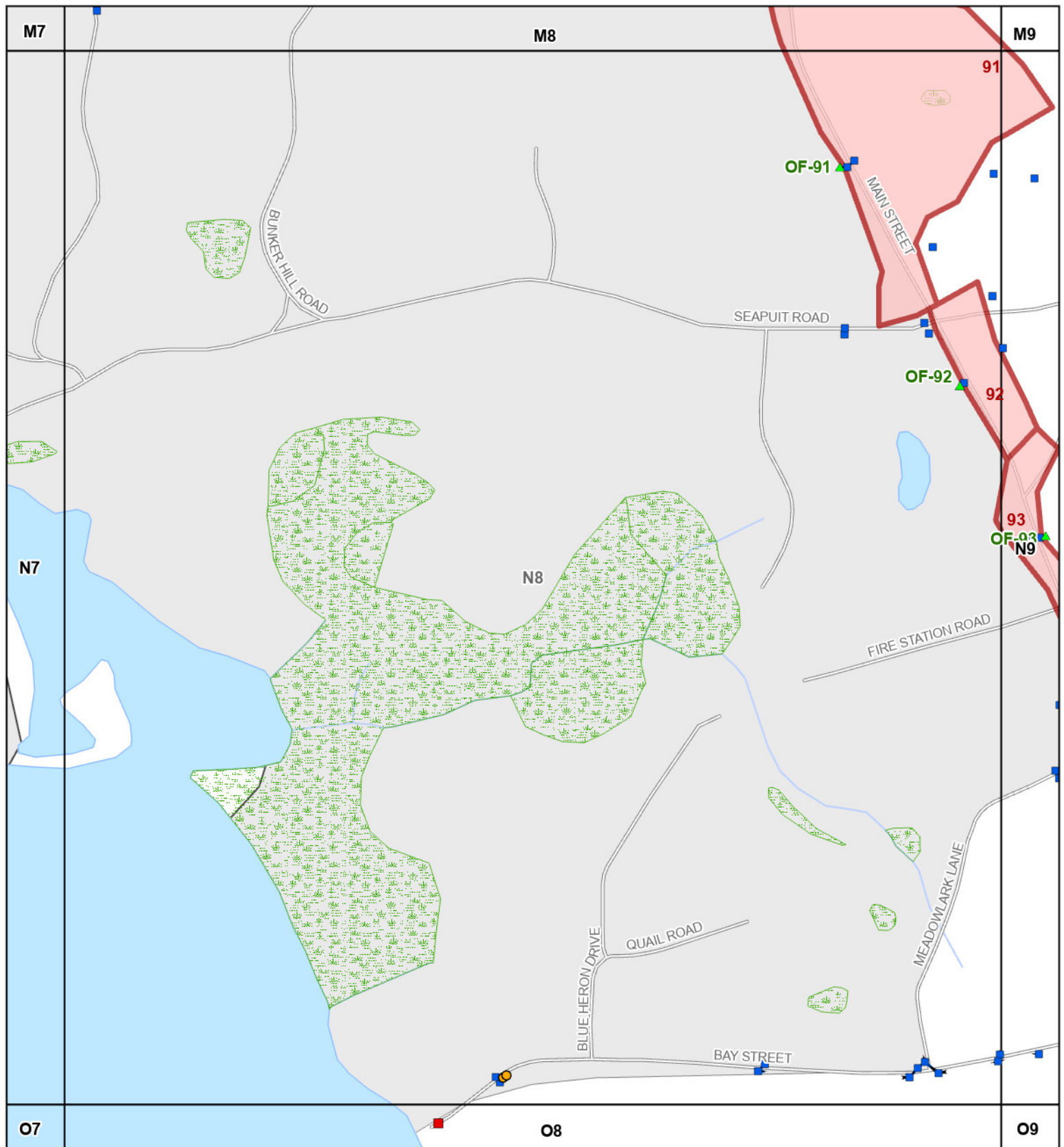
SHEET

N7

0 100 200 300 400 500
Feet



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| ● Drainage Manhole | — Storm Water Gravity Drain |
| ■ Stormwater BMP | — Swale |
| ★ Key Drainage Manhole | — Catchment |
| ✚ Interconnections | — Non-Urban Area |
| ▲ DOT Outfall | |

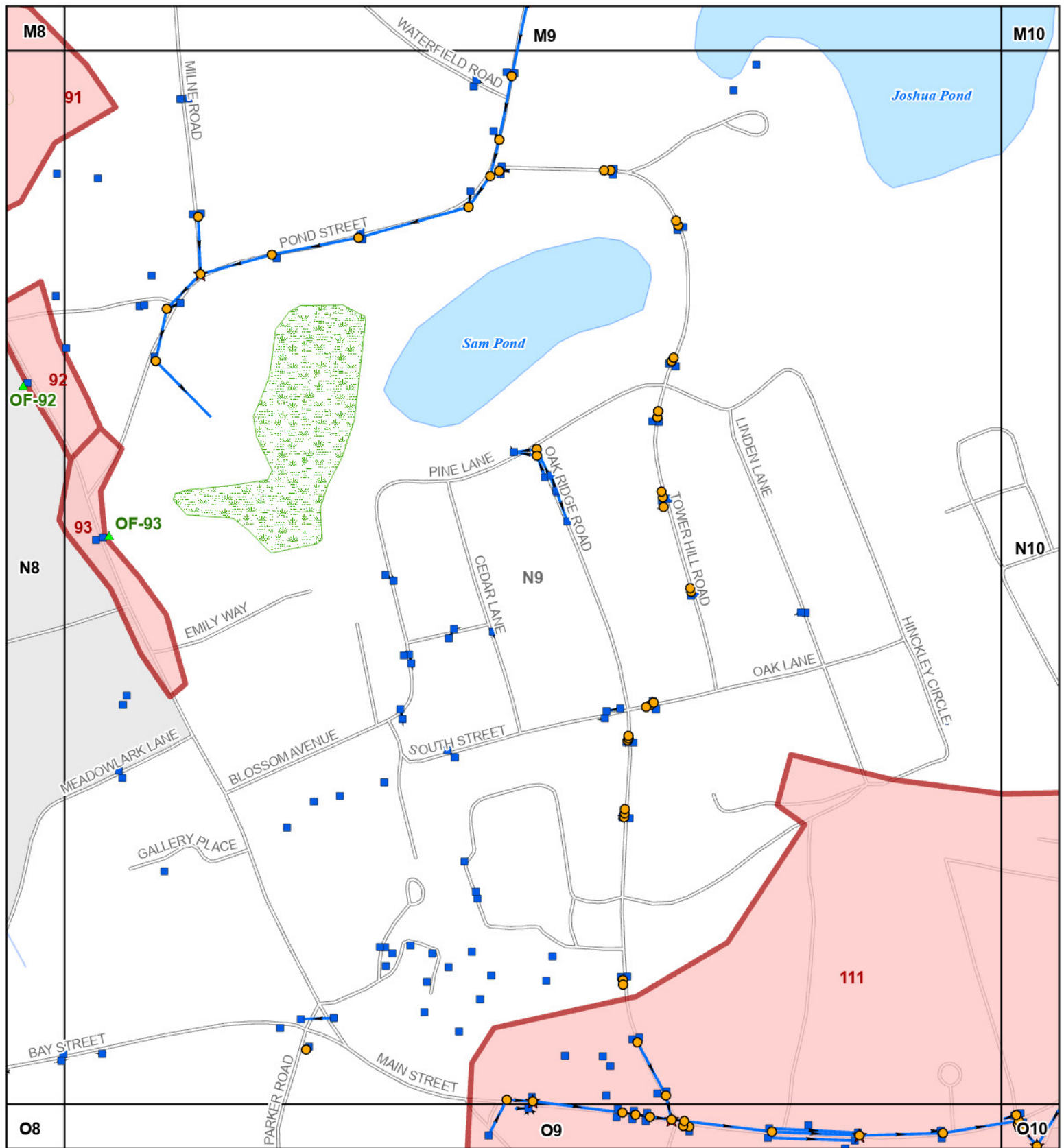
Stormwater Infrastructure Map Barnstable, MA

SHEET
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Feet



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| ▲ Outfalls | ● DOT Manhole |
| ■ Catch Basin | ■ DOT Catch Basin |
| ● Drainage Manhole | — Storm Water Gravity Drain |
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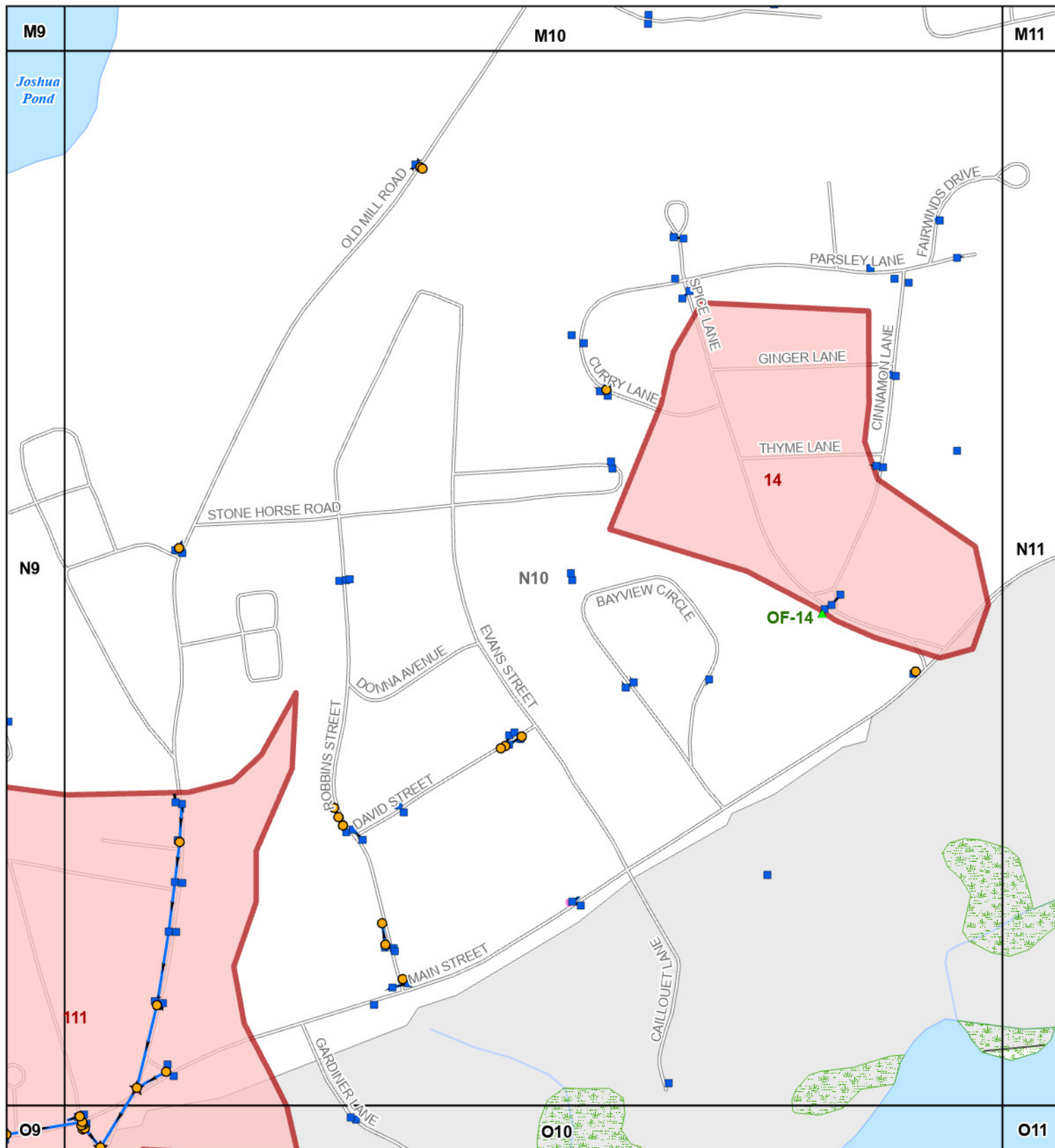
Stormwater Infrastructure Map Barnstable, MA

SHEET
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0 100 200 300 400 500
Feet



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| ▲ Outfalls | ○ DOT Manhole |
| ■ Catch Basin | ■ DOT Catch Basin |
| ● Drainage Manhole | — Storm Water Gravity Drain |
| ■ Stormwater BMP | — Swale |
| ★ Key Drainage Manhole | — Catchment |
| ✚ Interconnections | — Non-Urban Area |
| △ DOT Outfall | |

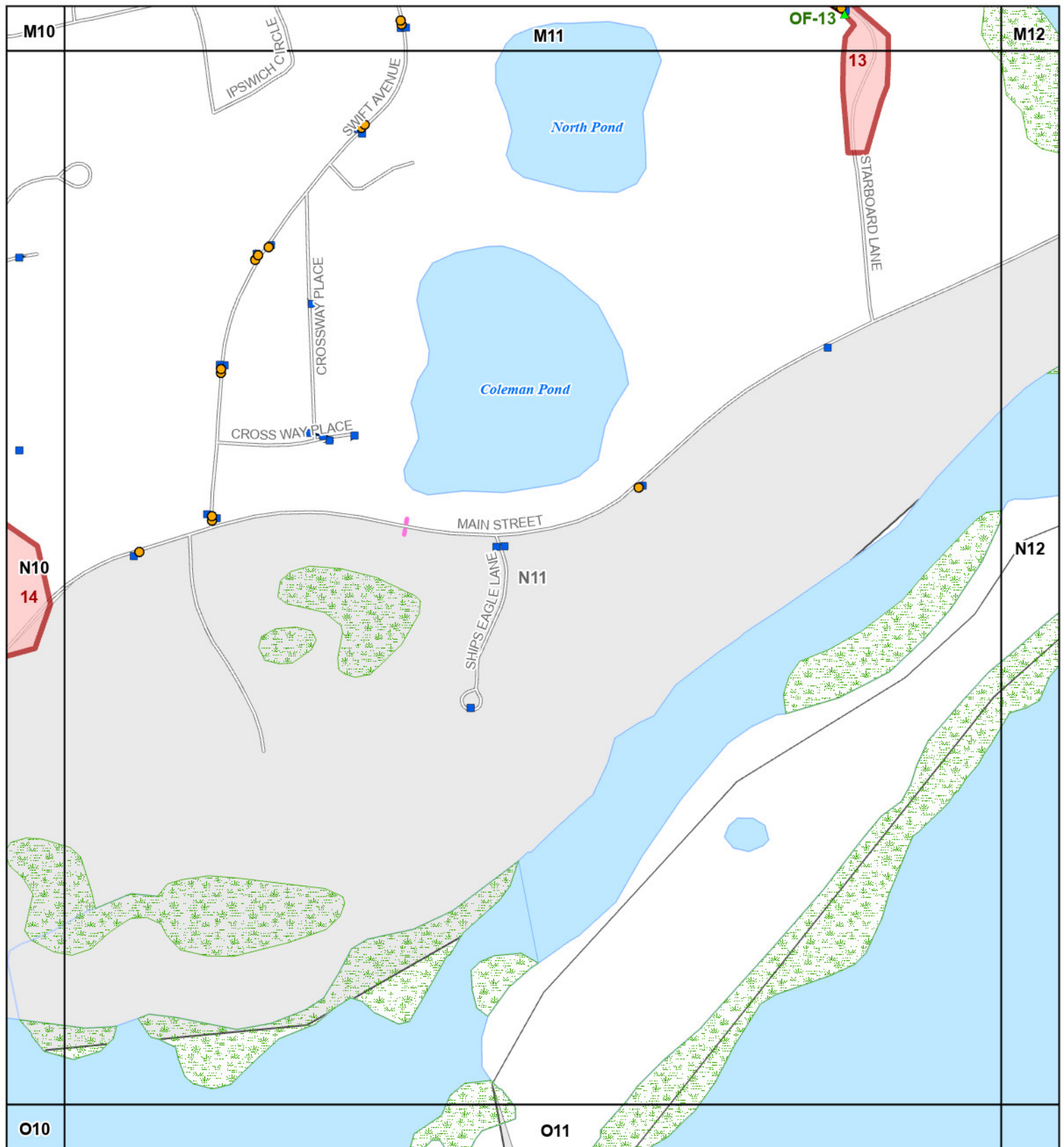
Stormwater Infrastructure Map Barnstable, MA

SHEET
N10

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Feet



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| ■ Catch Basin | ■ DOT Catch Basin |
| ● Drainage Manhole | — Storm Water Gravity Drain |
| ■ Stormwater BMP | — Swale |
| ★ Key Drainage Manhole | — Catchment |
| ✚ Interconnections | — Non-Urban Area |
| ▲ DOT Outfall | |

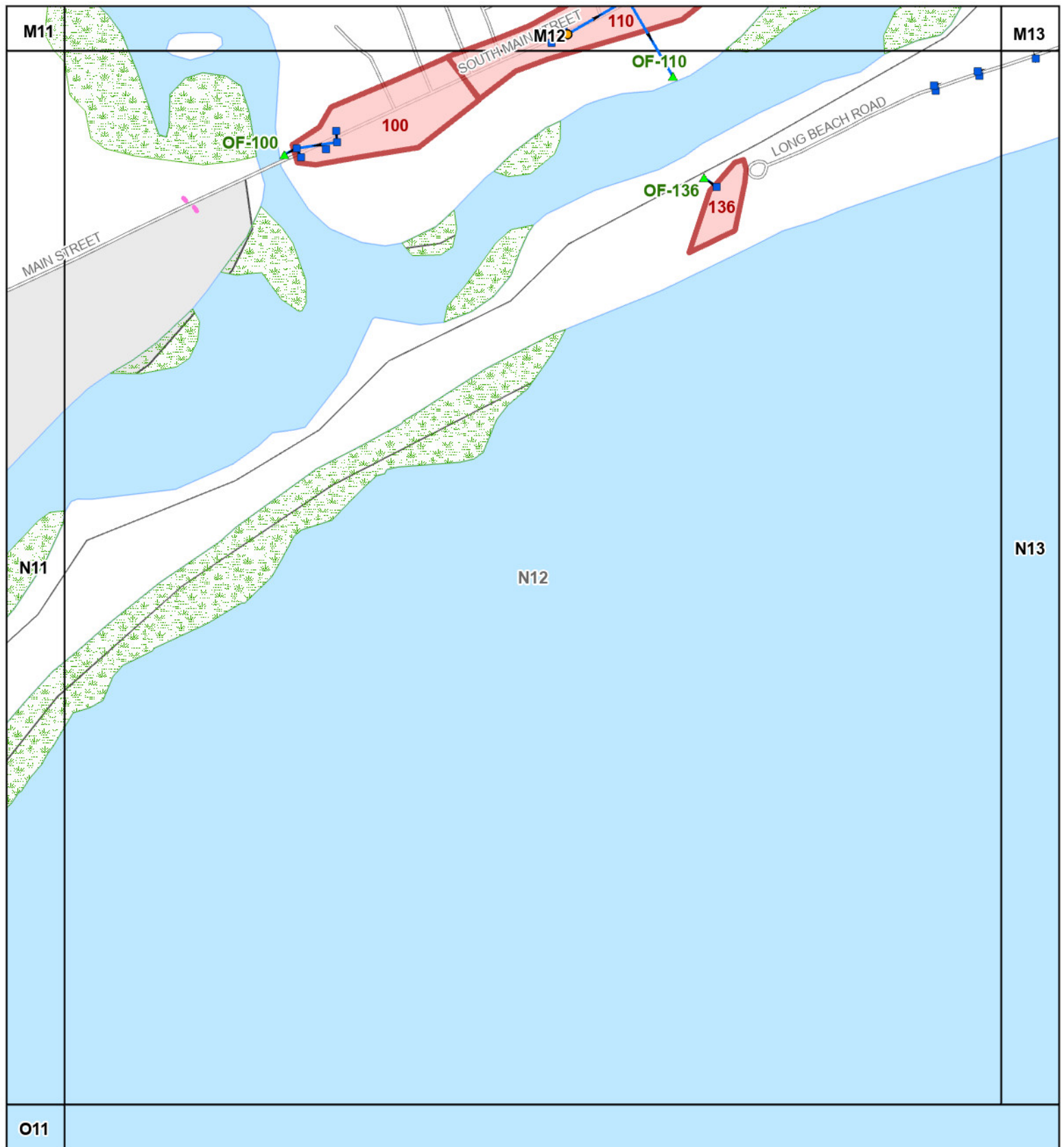
Stormwater Infrastructure Map Barnstable, MA

SHEET
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Feet



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| ■ Catch Basin | ■ DOT Catch Basin |
| ● Drainage Manhole | — Storm Water Gravity Drain |
| ■ Stormwater BMP | — Swale |
| ★ Key Drainage Manhole | — Catchment |
| ✚ Interconnections | — Non-Urban Area |
| ▲ DOT Outfall | |

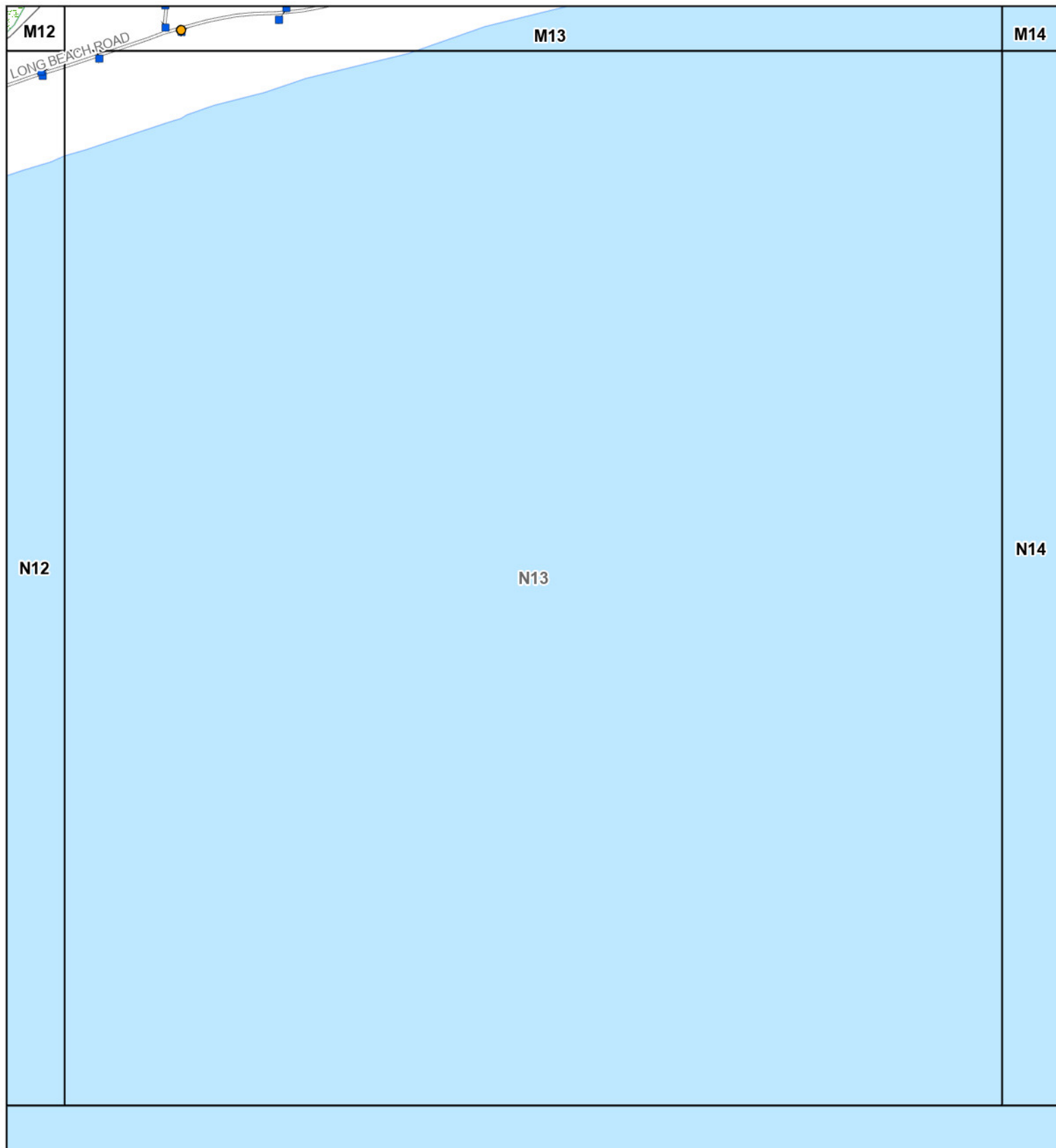
Stormwater Infrastructure Map Barnstable, MA

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Feet



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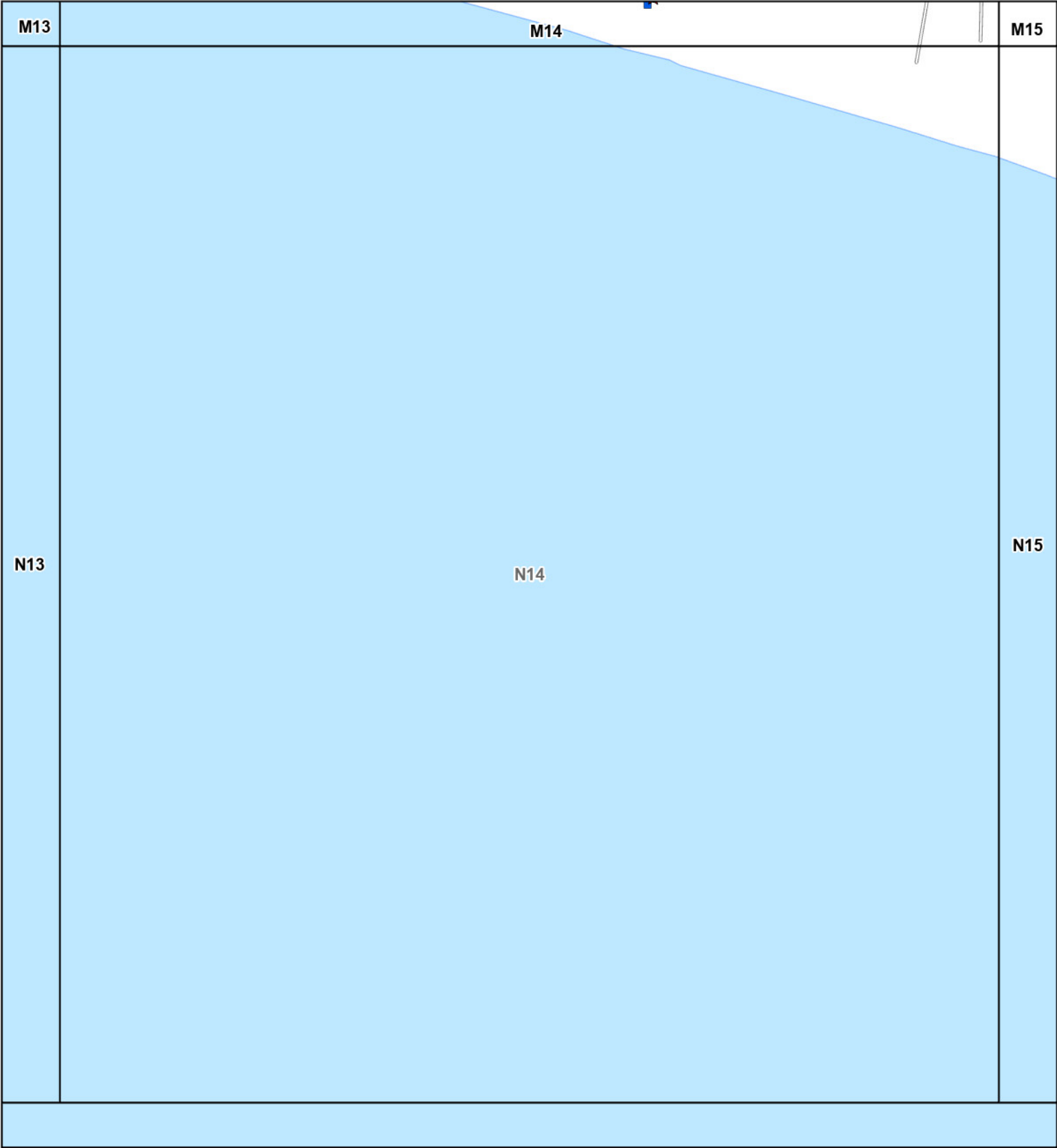


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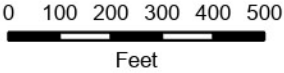
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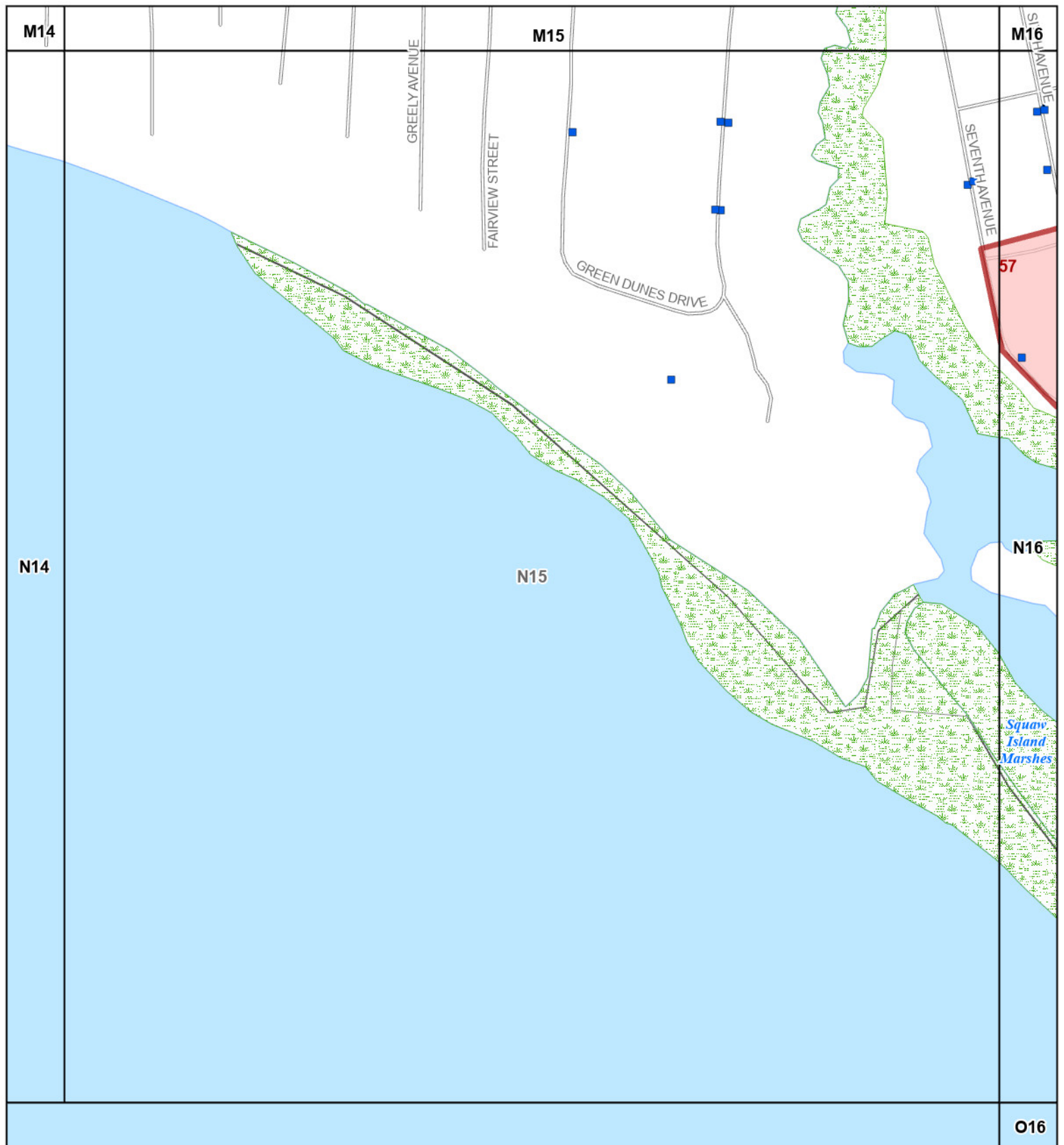
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| ■ Stormwater BMP | — Swale |
| ★ Key Drainage Manhole | — Catchment |
| ✚ Interconnections | — Non-Urban Area |
| ▲ DOT Outfall | |

Stormwater Infrastructure Map Barnstable, MA

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| ▲ Outfalls | ○ DOT Manhole |
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| ● Drainage Manhole | — Storm Water Gravity Drain |
| ■ Stormwater BMP | — Swale |
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| ✚ Interconnections | — Non-Urban Area |
| ▲ DOT Outfall | |

Stormwater Infrastructure Map Barnstable, MA

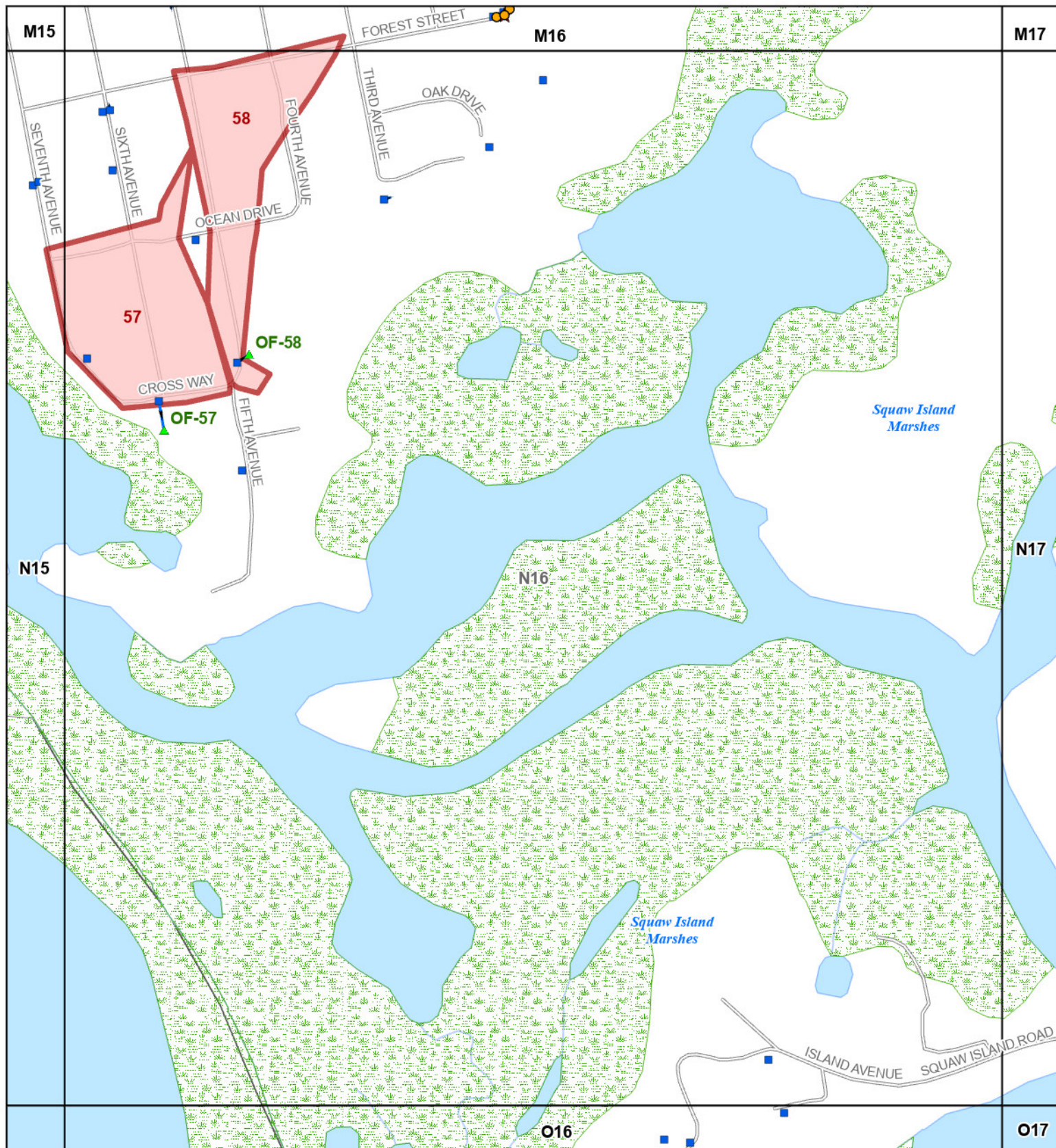
SHEET

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| ● Drainage Manhole | — Storm Water Gravity Drain |
| ■ Stormwater BMP | — Swale |
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| ✚ Interconnections | — Non-Urban Area |
| ▲ DOT Outfall | |

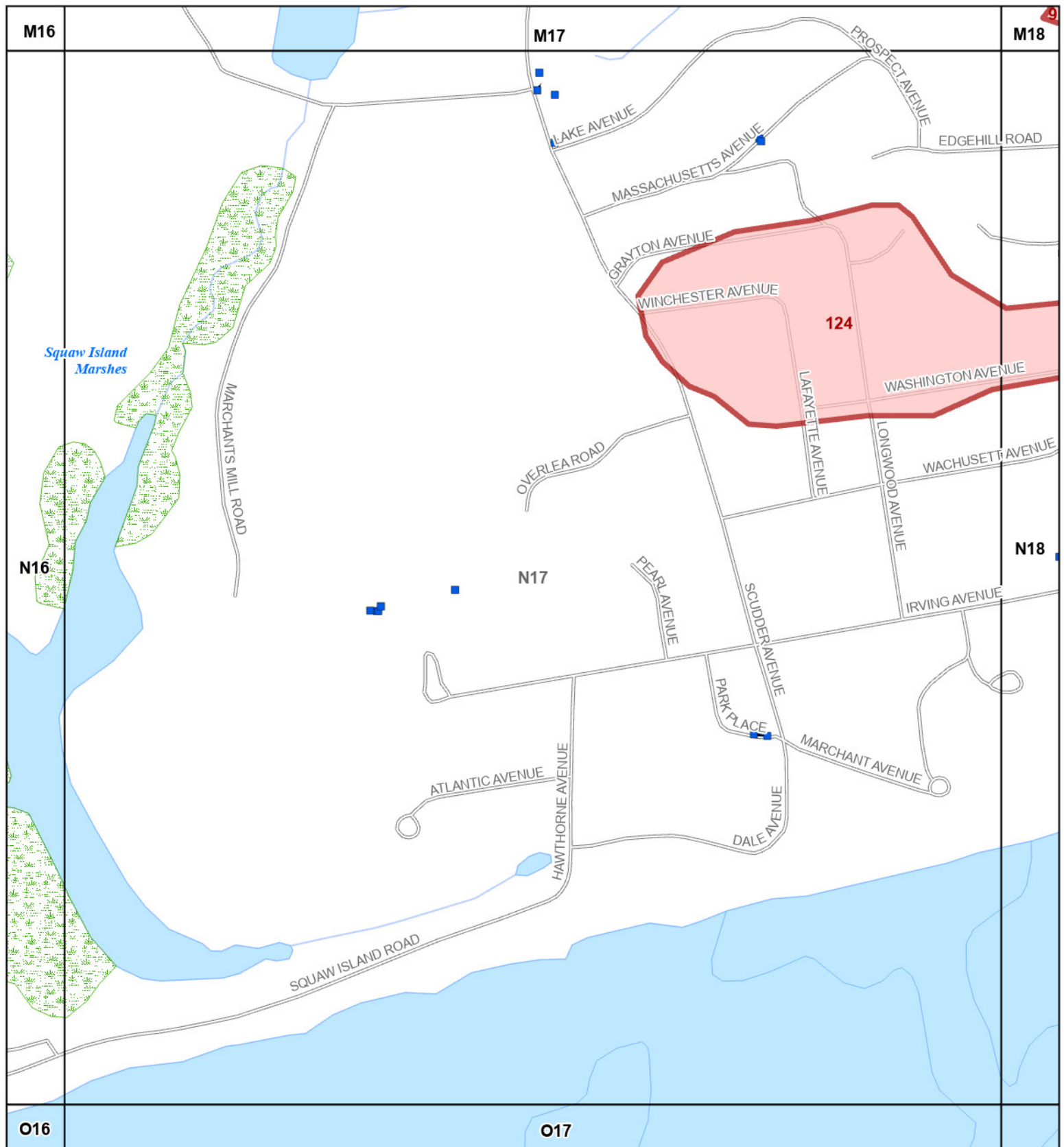
Stormwater Infrastructure Map Barnstable, MA

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| ▲ Outfalls | ● DOT Manhole |
| ■ Catch Basin | ■ DOT Catch Basin |
| ● Drainage Manhole | — Storm Water Gravity Drain |
| ■ Stormwater BMP | — Swale |
| ★ Key Drainage Manhole | — Catchment |
| ✚ Interconnections | — Non-Urban Area |
| ▲ DOT Outfall | |

Stormwater Infrastructure Map Barnstable, MA

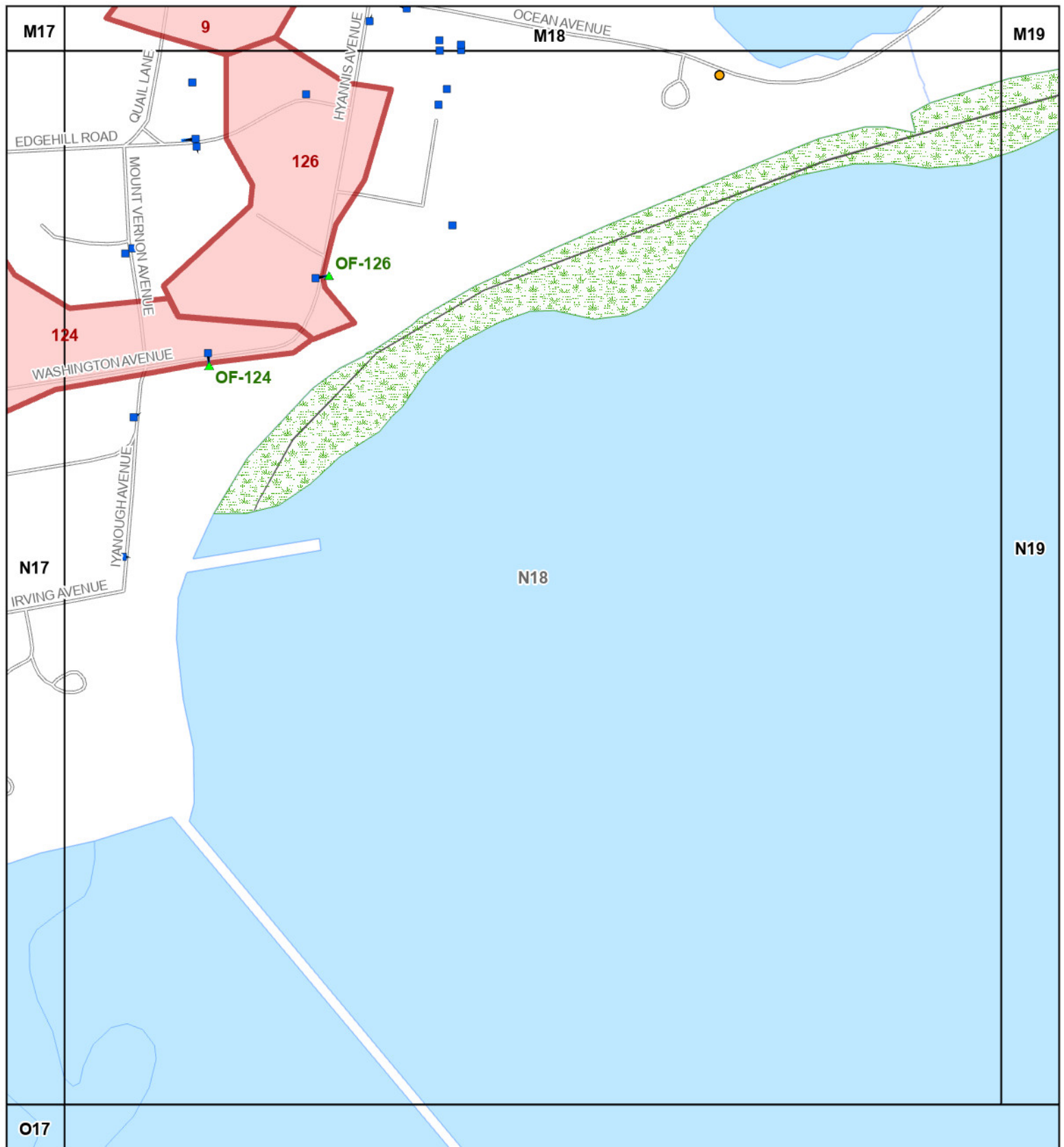
SHEET

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Feet



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| ■ Catch Basin | ■ DOT Catch Basin |
| ● Drainage Manhole | — Storm Water Gravity Drain |
| ■ Stormwater BMP | — Swale |
| ★ Key Drainage Manhole | — Catchment |
| ✚ Interconnections | — Non-Urban Area |
| ▲ DOT Outfall | |

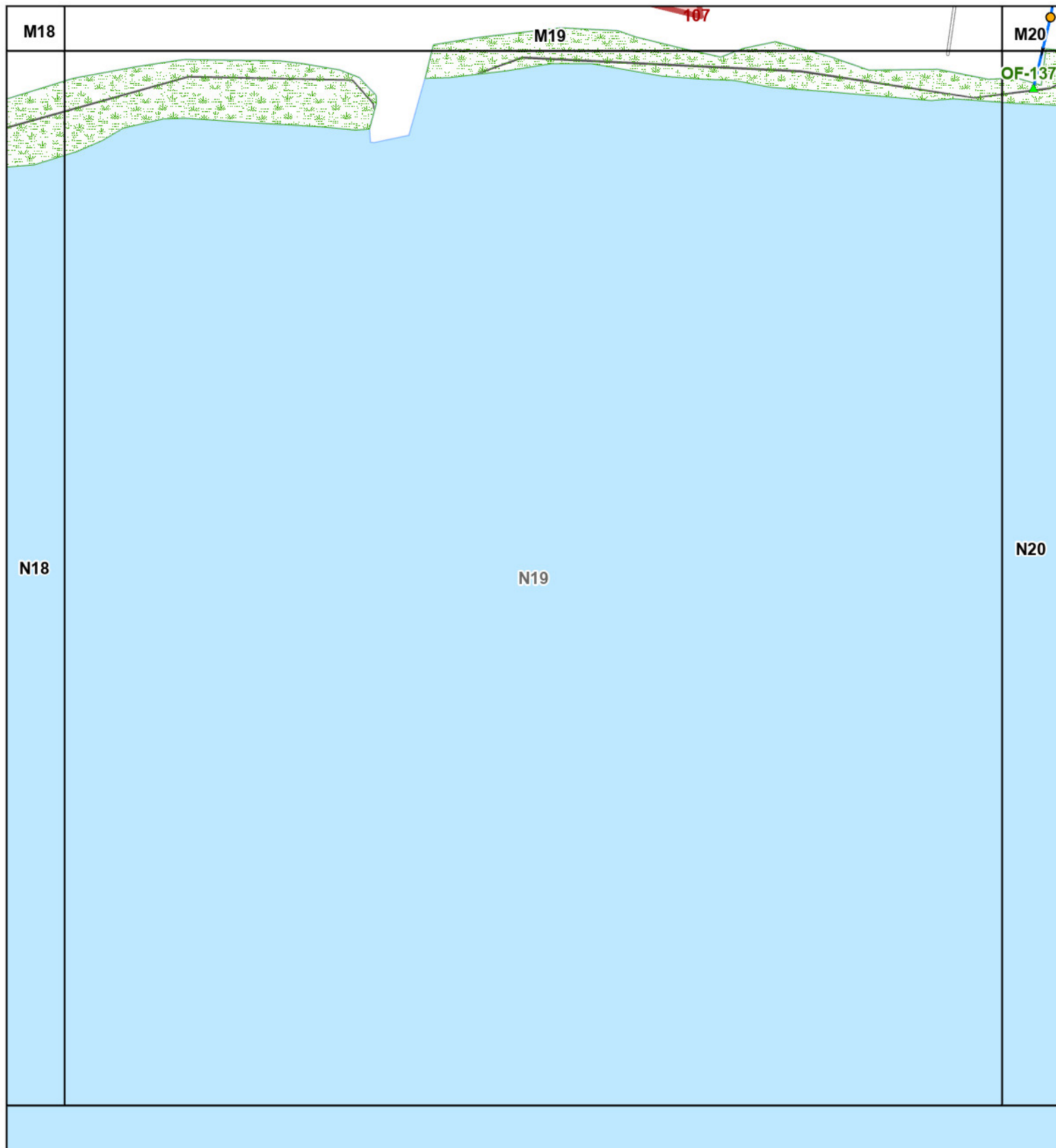
Stormwater Infrastructure Map Barnstable, MA

SHEET
N18

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| ▲ Outfalls | ● DOT Manhole |
| ■ Catch Basin | ■ DOT Catch Basin |
| ● Drainage Manhole | — Storm Water Gravity Drain |
| ■ Stormwater BMP | — Swale |
| ★ Key Drainage Manhole | — Catchment |
| ✚ Interconnections | — Non-Urban Area |
| ▲ DOT Outfall | |

Stormwater Infrastructure Map Barnstable, MA

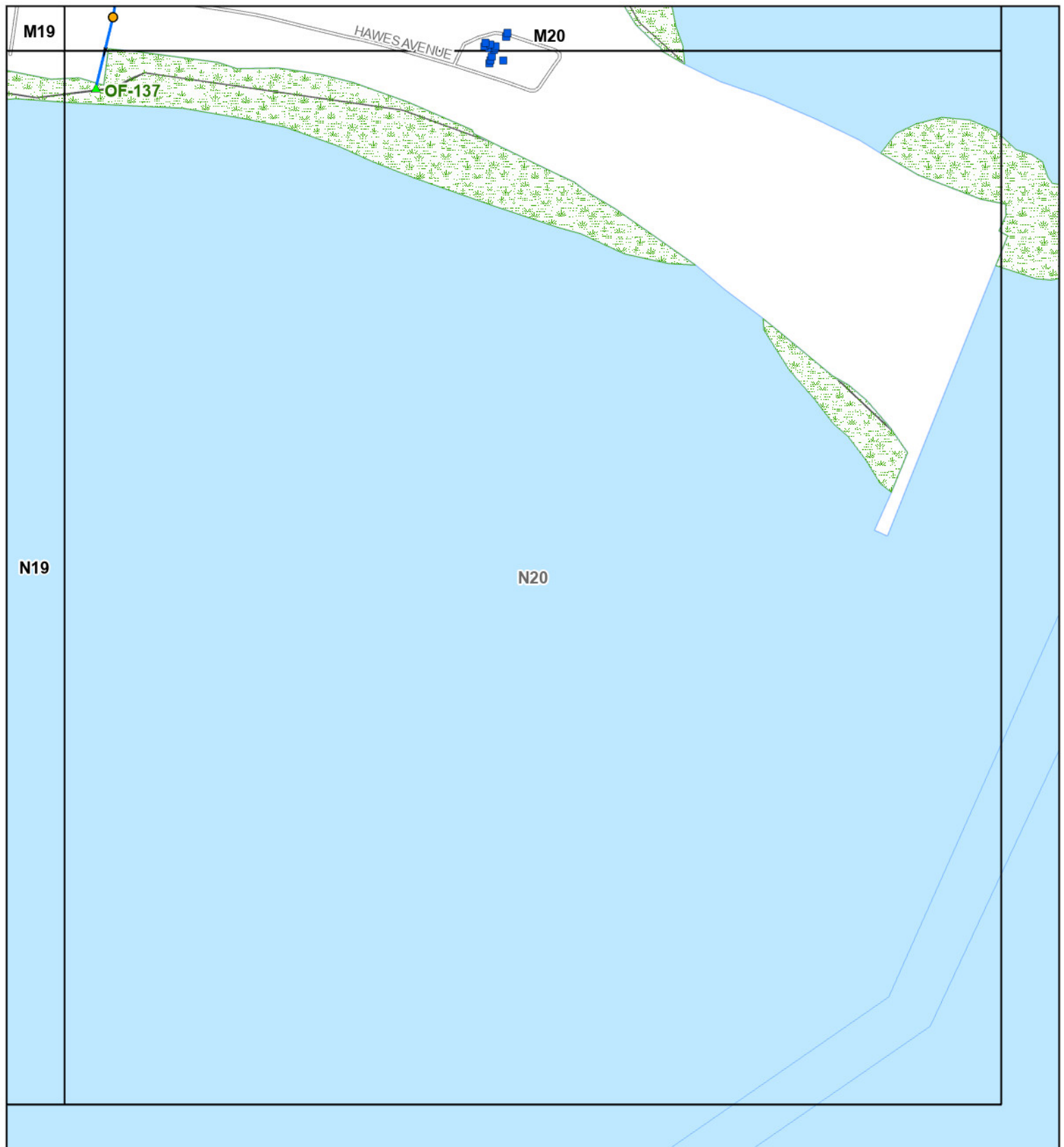
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Feet



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| ● Drainage Manhole | — Storm Water Gravity Drain |
| ■ Stormwater BMP | — Swale |
| ★ Key Drainage Manhole | — Catchment |
| ✚ Interconnections | — Non-Urban Area |
| ▲ DOT Outfall | |

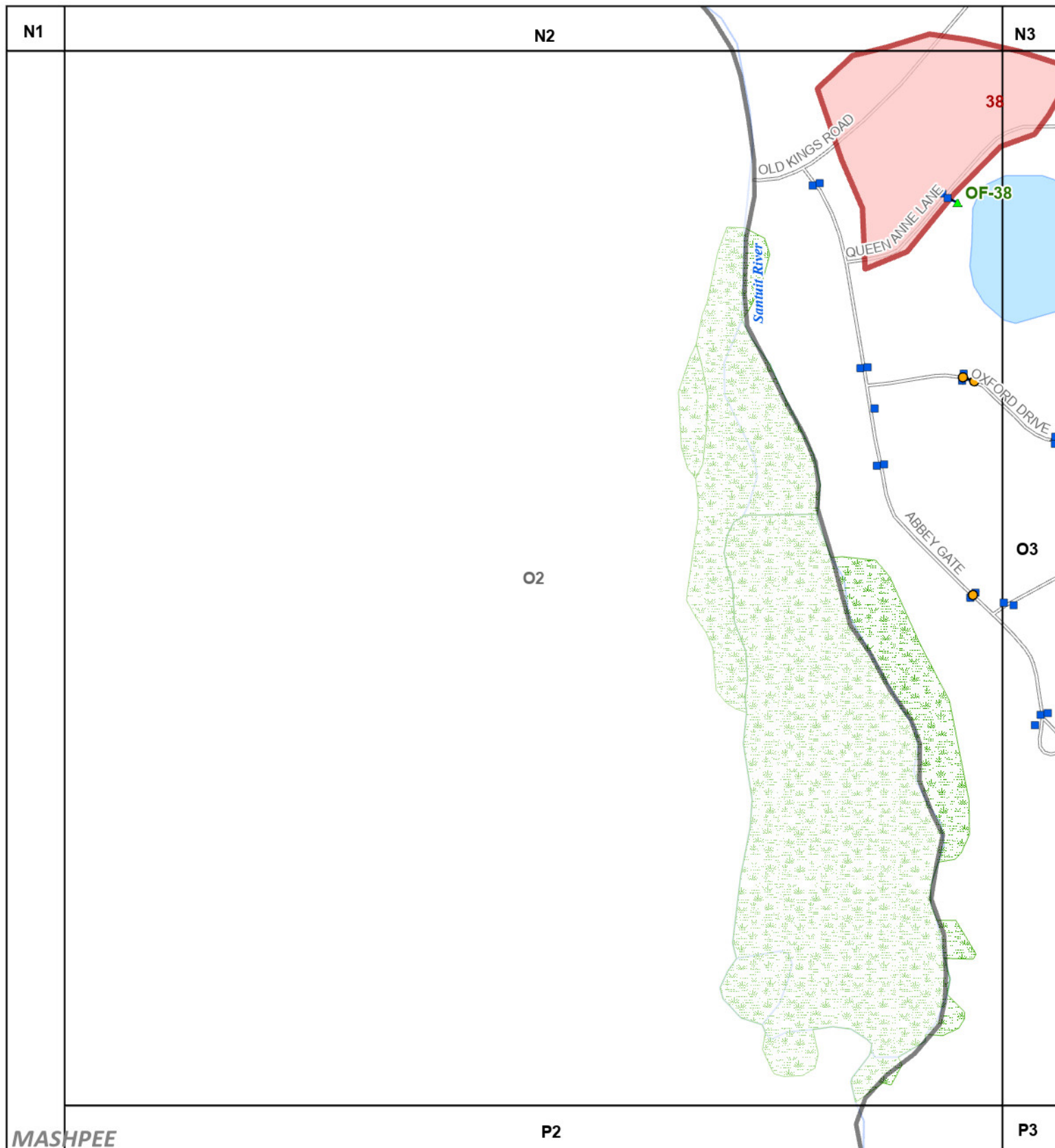
Stormwater Infrastructure Map Barnstable, MA

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| ■ Catch Basin | ■ DOT Catch Basin |
| ● Drainage Manhole | — Storm Water Gravity Drain |
| ■ Stormwater BMP | — Swale |
| ★ Key Drainage Manhole | — Catchment |
| ✚ Interconnections | — Non-Urban Area |
| △ DOT Outfall | |

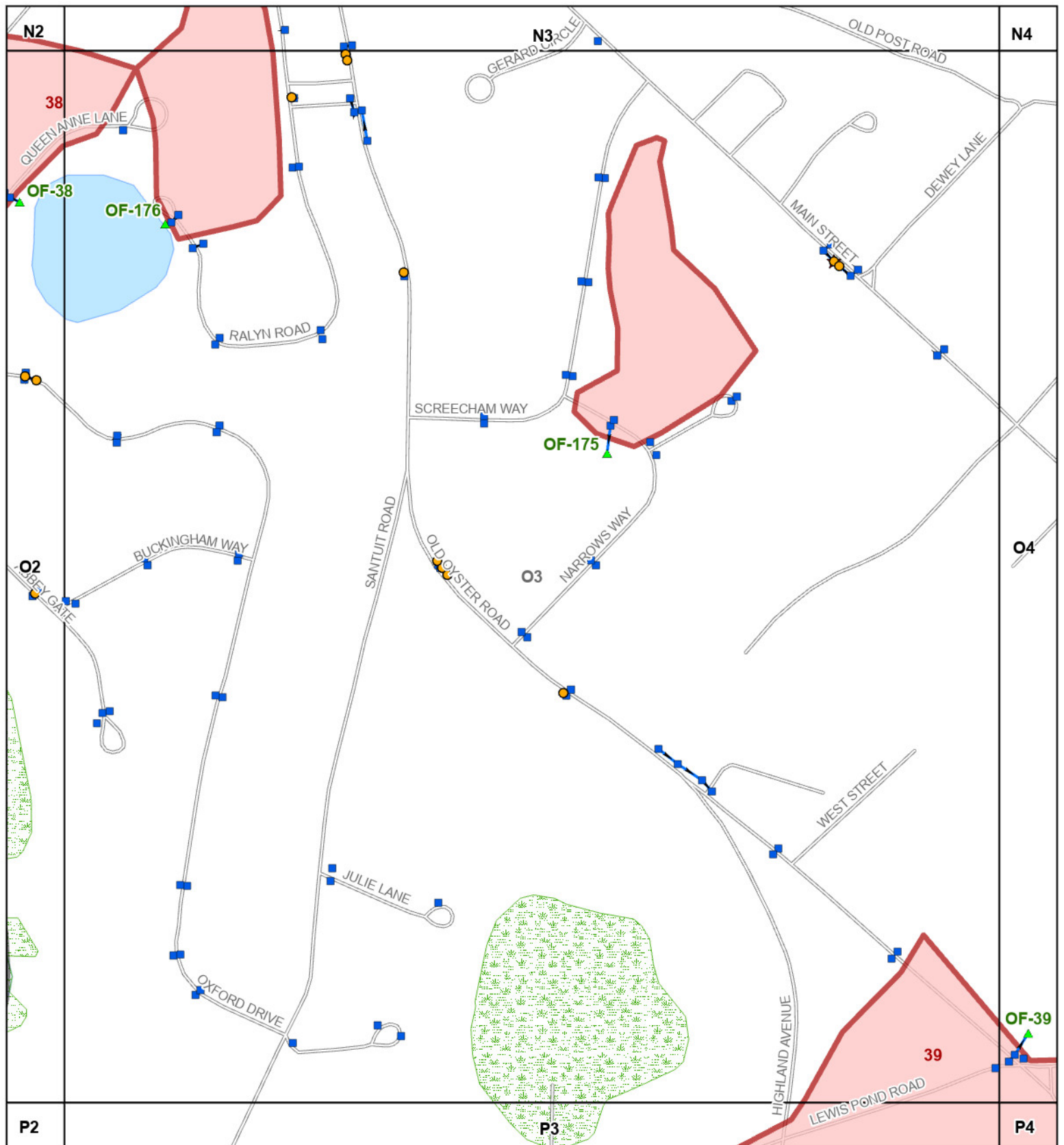
Stormwater Infrastructure Map Barnstable, MA

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Feet



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| ▲ Outfalls | ○ DOT Manhole |
| ■ Catch Basin | ■ DOT Catch Basin |
| ● Drainage Manhole | — Storm Water Gravity Drain |
| ■ Stormwater BMP | — Swale |
| ★ Key Drainage Manhole | — Catchment |
| ✚ Interconnections | — Non-Urban Area |
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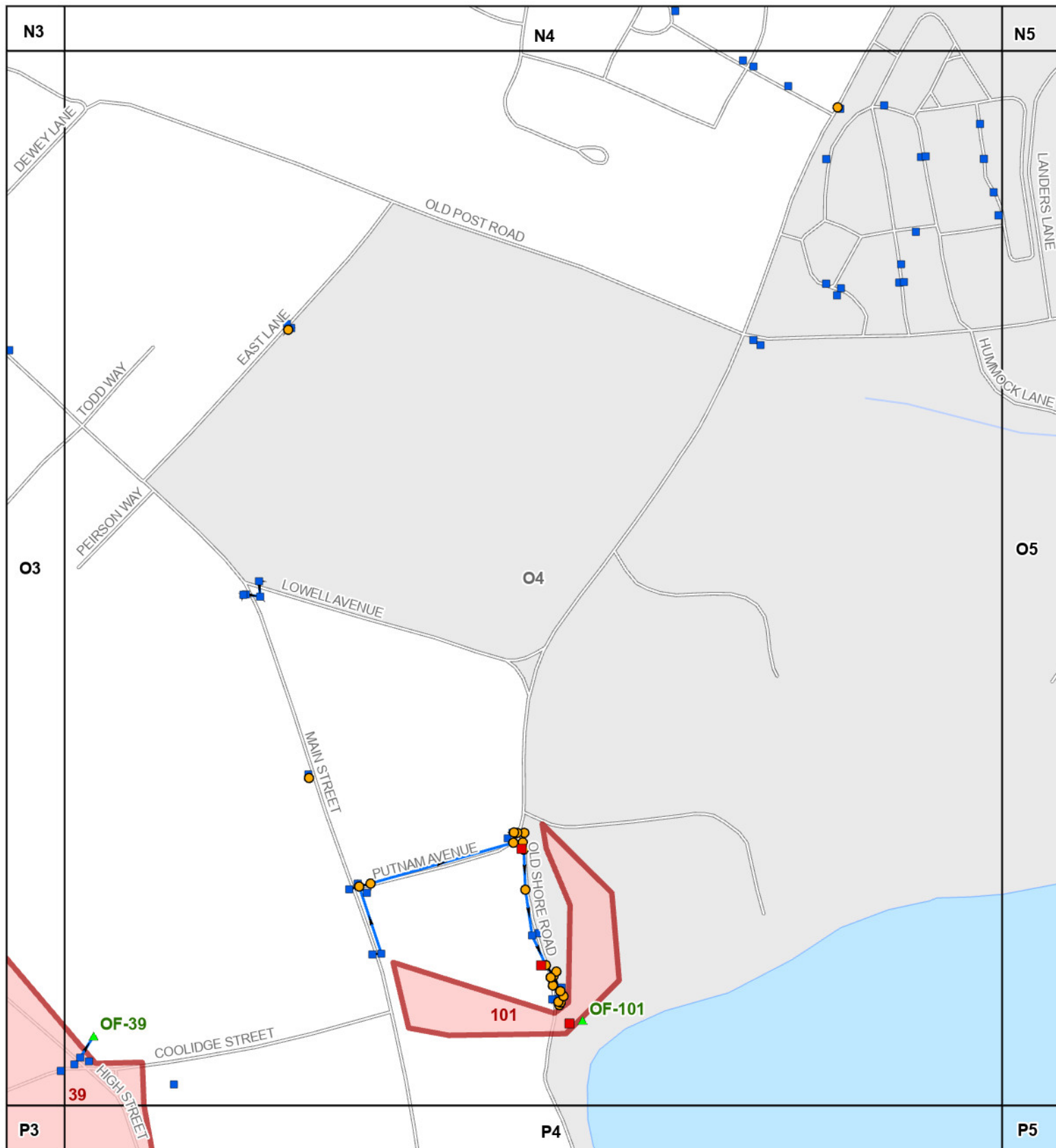
Stormwater Infrastructure Map Barnstable, MA

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| ▲ Outfalls | ○ DOT Manhole |
| ■ Catch Basin | ■ DOT Catch Basin |
| ● Drainage Manhole | — Storm Water Gravity Drain |
| ■ Stormwater BMP | — Swale |
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| ✚ Interconnections | — Non-Urban Area |
| △ DOT Outfall | |

Stormwater Infrastructure Map Barnstable, MA

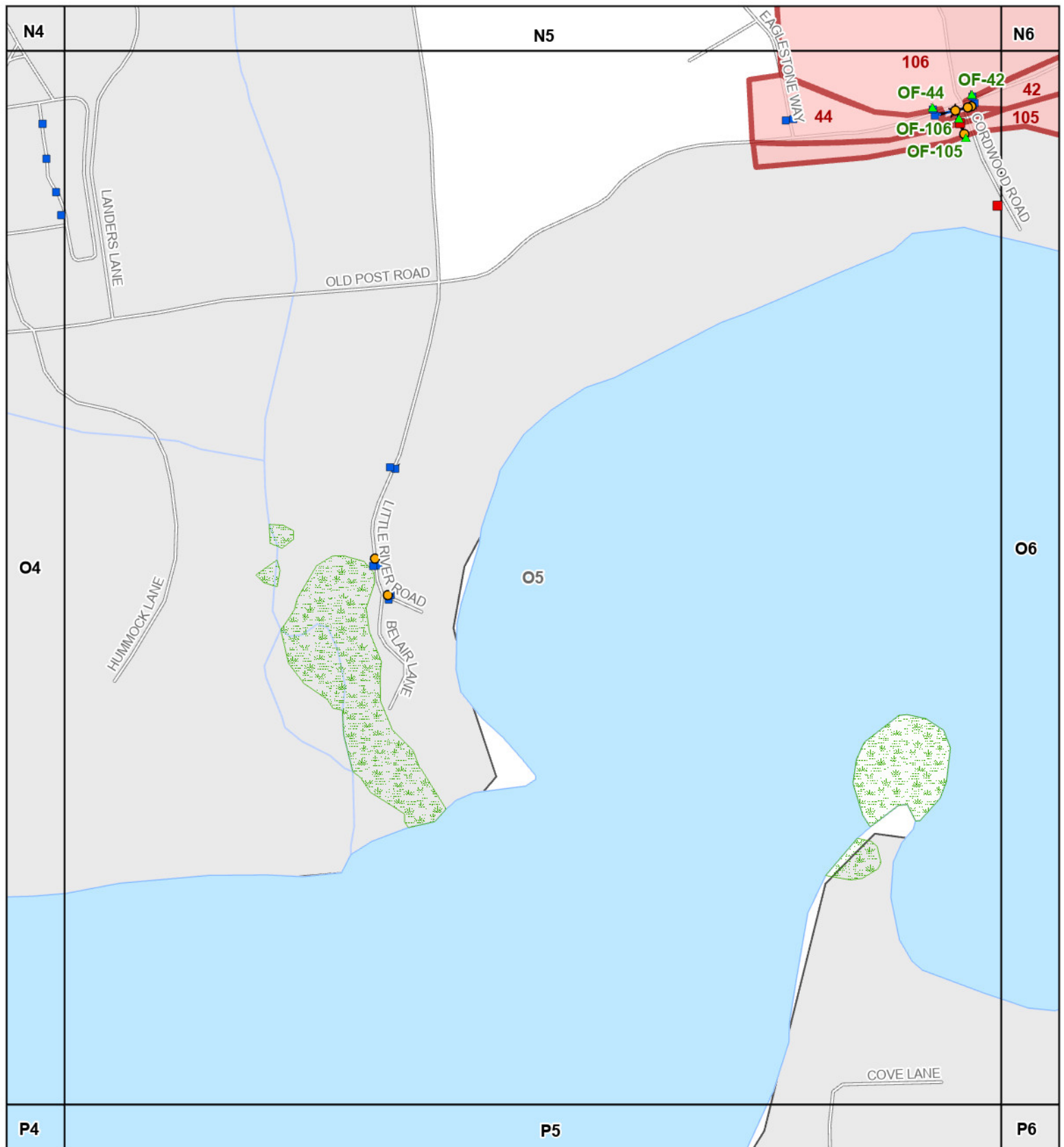
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Feet



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| ■ Catch Basin | ■ DOT Catch Basin |
| ● Drainage Manhole | — Storm Water Gravity Drain |
| ■ Stormwater BMP | — Swale |
| ★ Key Drainage Manhole | — Catchment |
| ✚ Interconnections | — Non-Urban Area |
| ▲ DOT Outfall | |

Stormwater Infrastructure Map Barnstable, MA

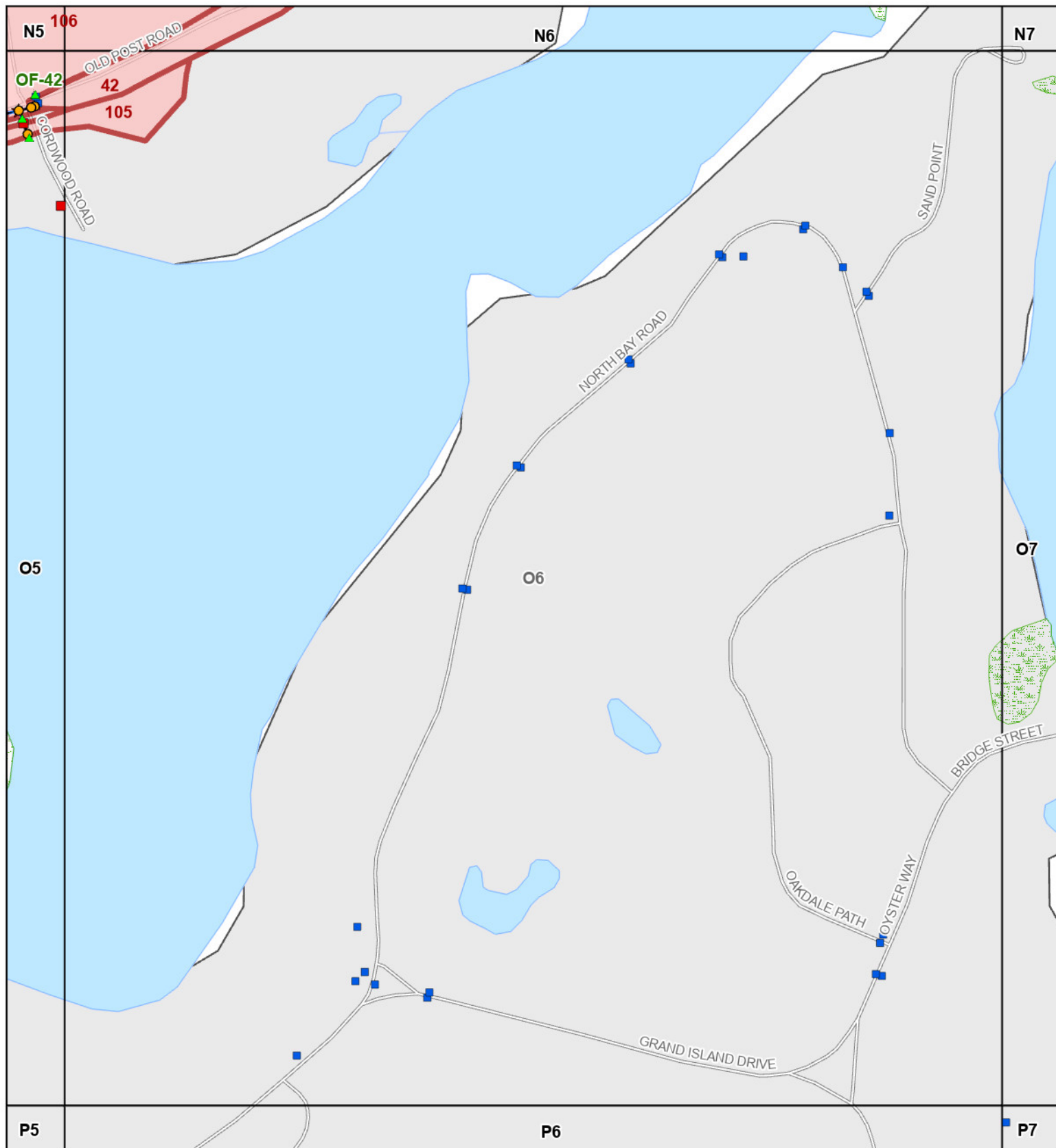
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| ● Drainage Manhole | — Storm Water Gravity Drain |
| ■ Stormwater BMP | — Swale |
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| ✚ Interconnections | — Non-Urban Area |
| ▲ DOT Outfall | |

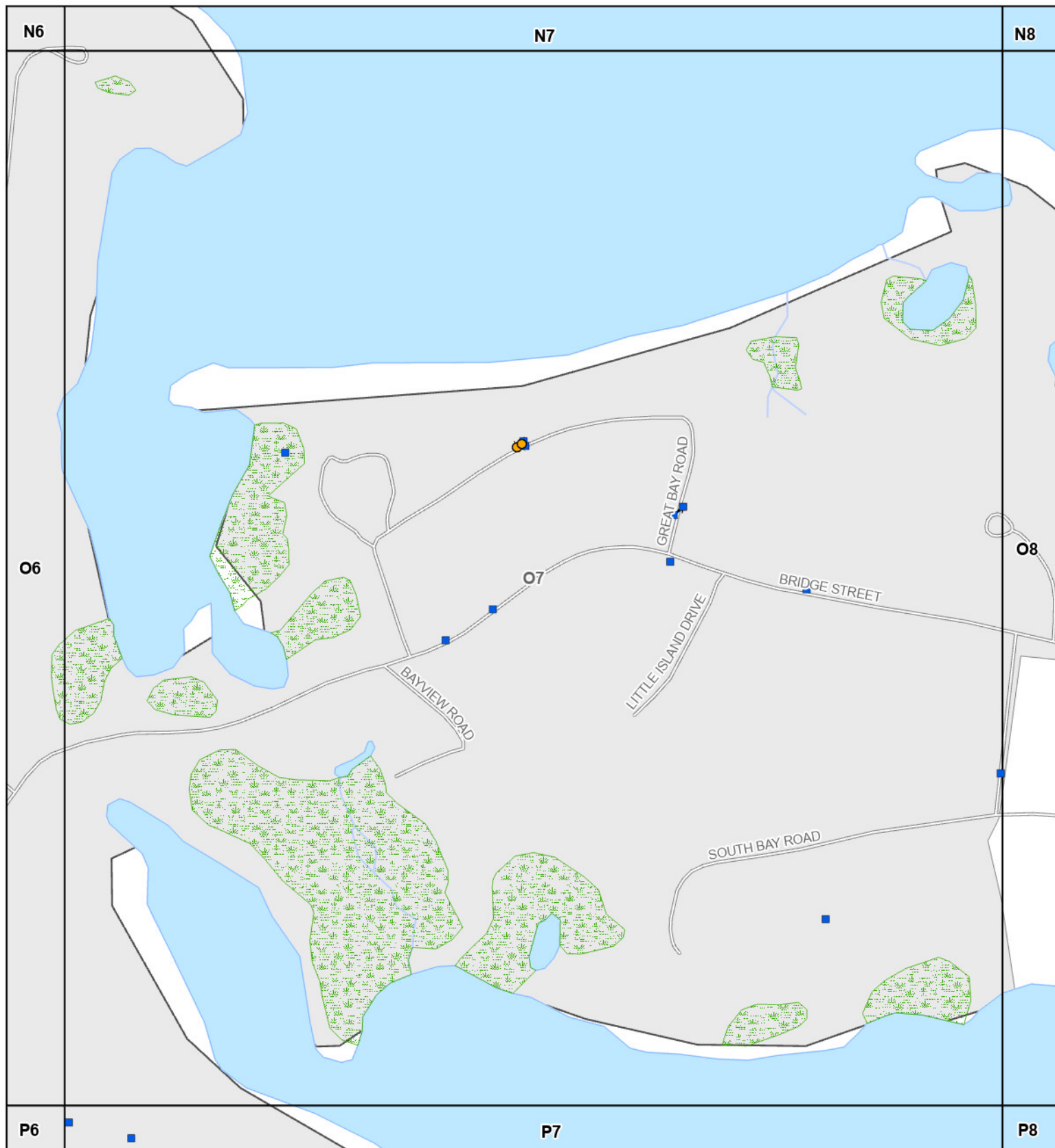
Stormwater Infrastructure Map Barnstable, MA

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| ▲ Outfalls | ● DOT Manhole |
| ■ Catch Basin | ■ DOT Catch Basin |
| ● Drainage Manhole | — Storm Water Gravity Drain |
| ■ Stormwater BMP | — Swale |
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| ✚ Interconnections | — Non-Urban Area |
| ▲ DOT Outfall | |

Stormwater Infrastructure Map Barnstable, MA

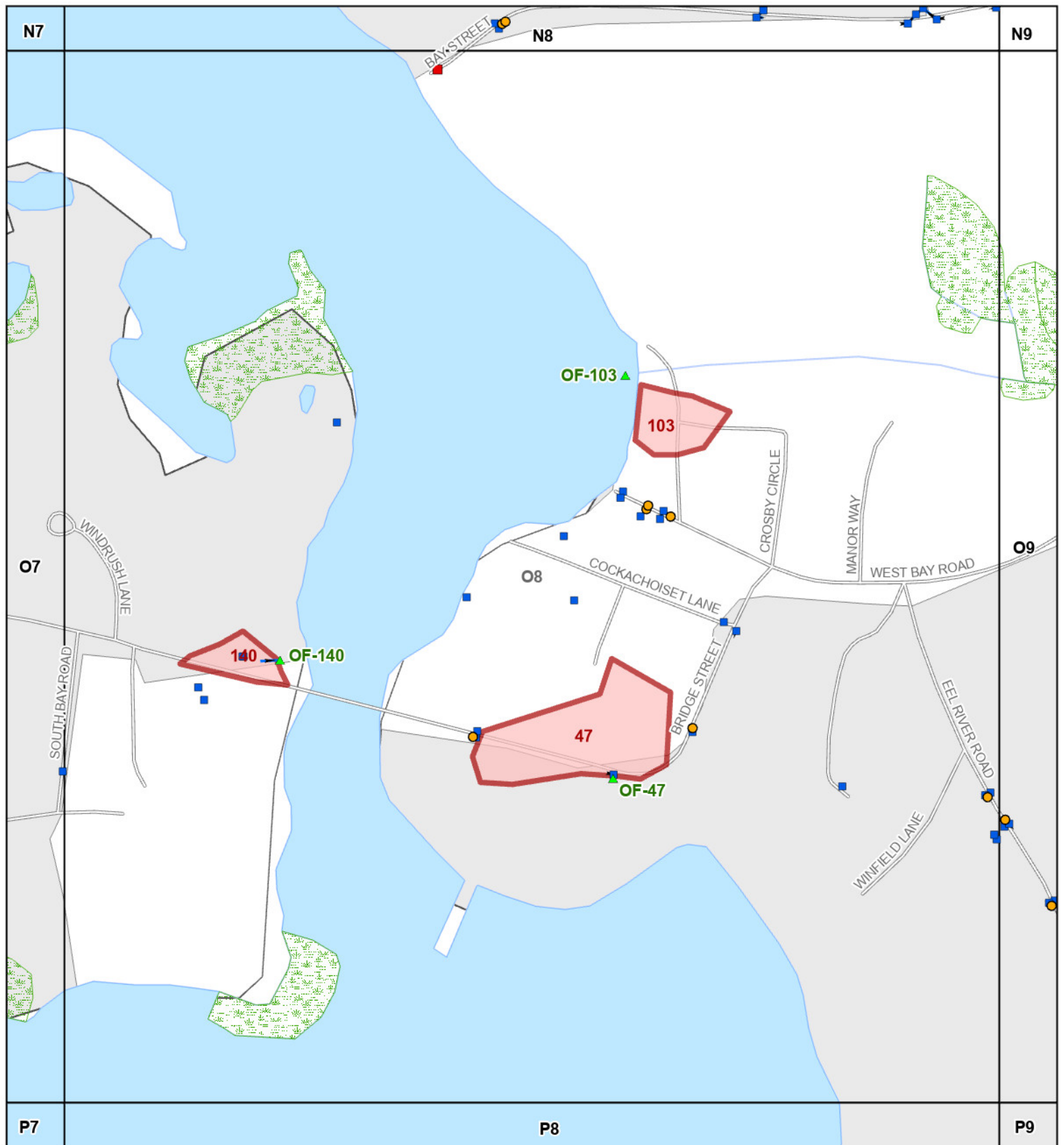
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| ■ Catch Basin | ■ DOT Catch Basin |
| ● Drainage Manhole | — Storm Water Gravity Drain |
| ■ Stormwater BMP | — Swale |
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| ✚ Interconnections | — Non-Urban Area |
| ▲ DOT Outfall | |

Stormwater Infrastructure Map Barnstable, MA

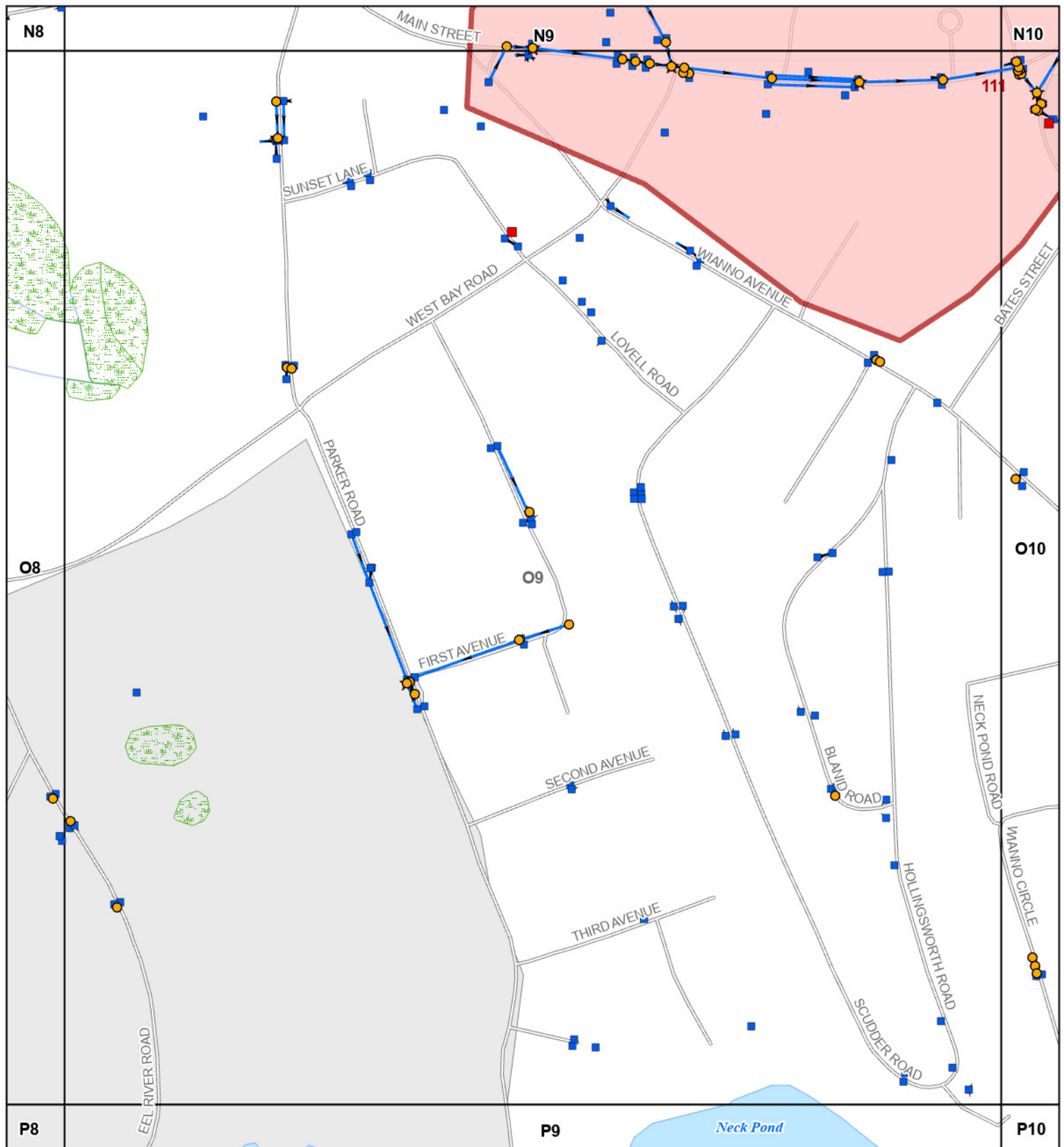
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| ■ Catch Basin | ■ DOT Catch Basin |
| ● Drainage Manhole | — Storm Water Gravity Drain |
| ■ Stormwater BMP | — Swale |
| ★ Key Drainage Manhole | — Catchment |
| ✚ Interconnections | — Non-Urban Area |
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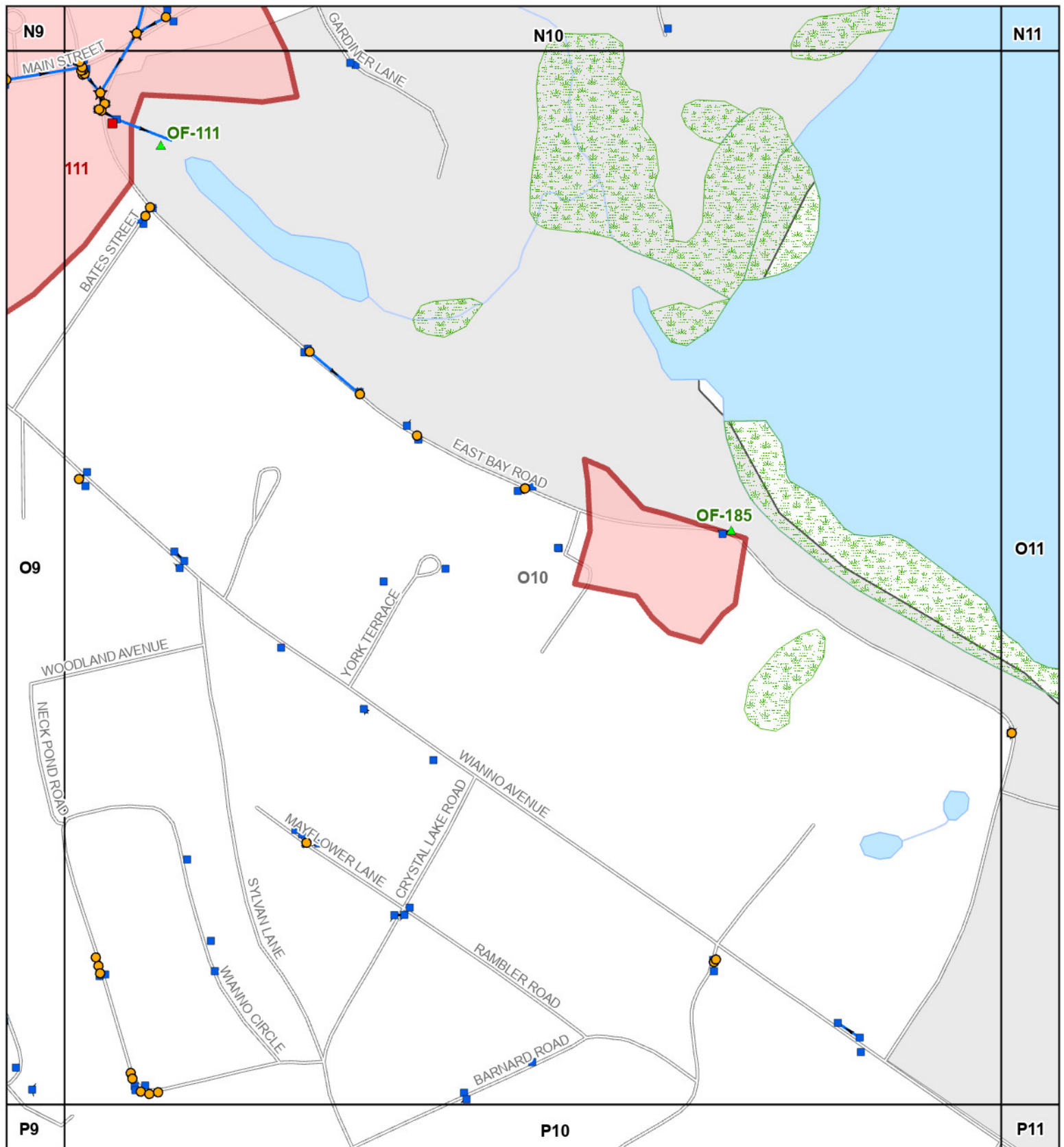
Stormwater Infrastructure Map Barnstable, MA

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| ■ Catch Basin | ■ DOT Catch Basin |
| ● Drainage Manhole | — Storm Water Gravity Drain |
| ■ Stormwater BMP | — Swale |
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| ✚ Interconnections | — Non-Urban Area |
| ▲ DOT Outfall | |

Stormwater Infrastructure Map Barnstable, MA

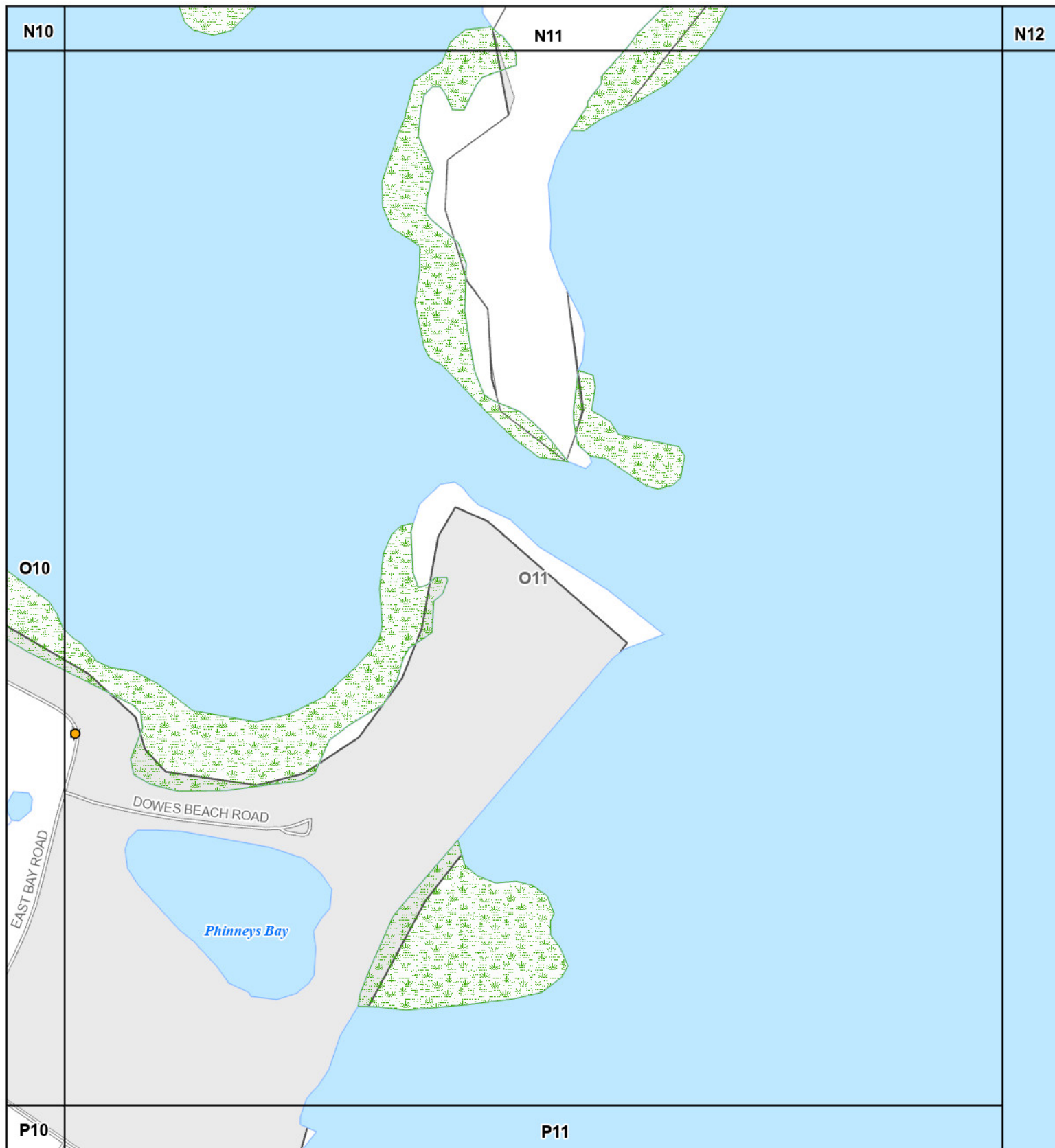
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| ● Drainage Manhole | — Storm Water Gravity Drain |
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| ✚ Interconnections | — Non-Urban Area |
| ▲ DOT Outfall | |

Stormwater Infrastructure Map Barnstable, MA

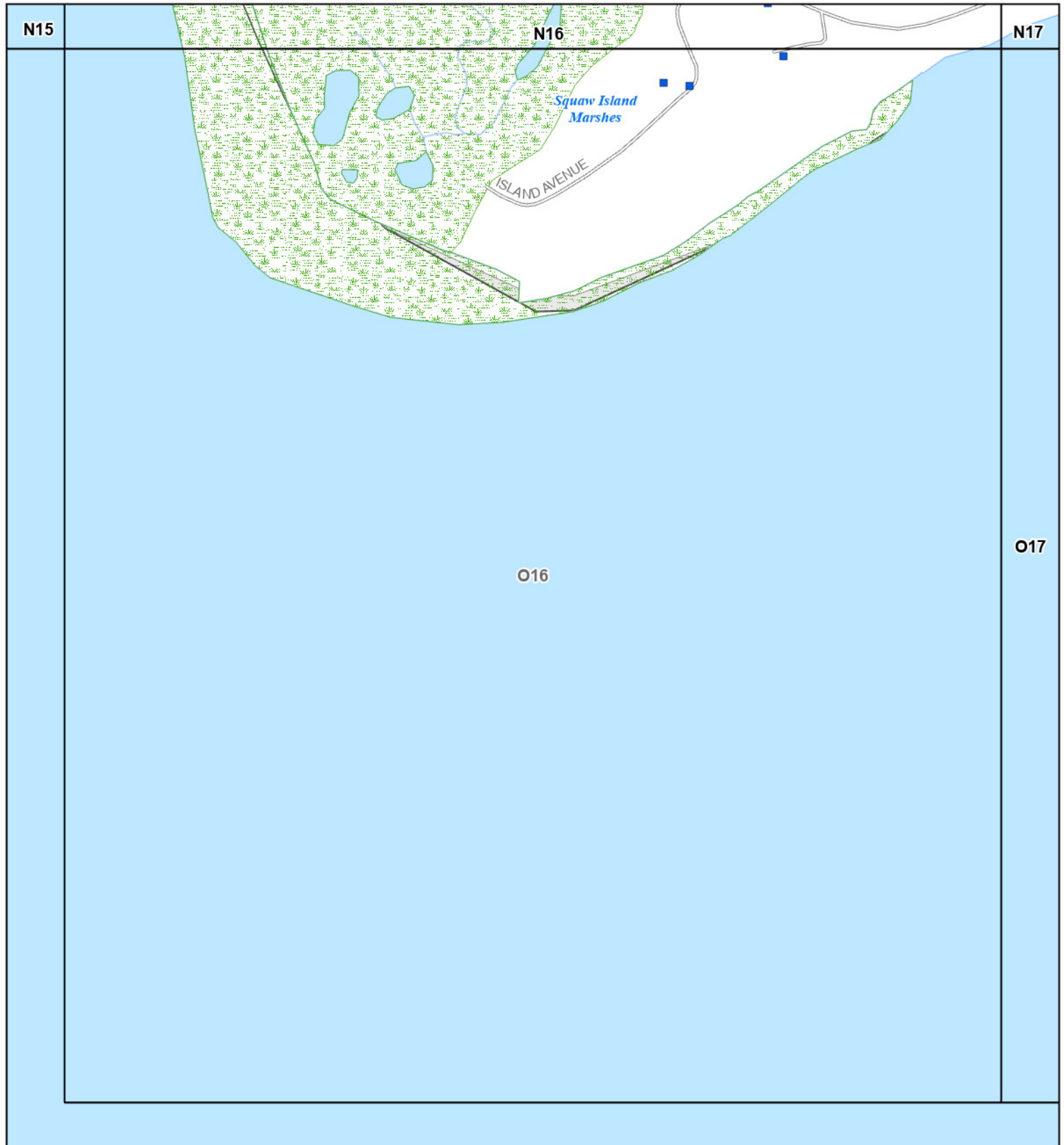
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| ● Drainage Manhole | — Storm Water Gravity Drain |
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| ★ Key Drainage Manhole | — Catchment |
| ✚ Interconnections | — Non-Urban Area |
| ▲ DOT Outfall | |

Stormwater Infrastructure Map Barnstable, MA

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| ▲ Outfalls | ● DOT Manhole |
| ■ Catch Basin | ■ DOT Catch Basin |
| ● Drainage Manhole | — Storm Water Gravity Drain |
| ■ Stormwater BMP | — Swale |
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| ✚ Interconnections | — Non-Urban Area |
| ▲ DOT Outfall | |

Stormwater Infrastructure Map Barnstable, MA

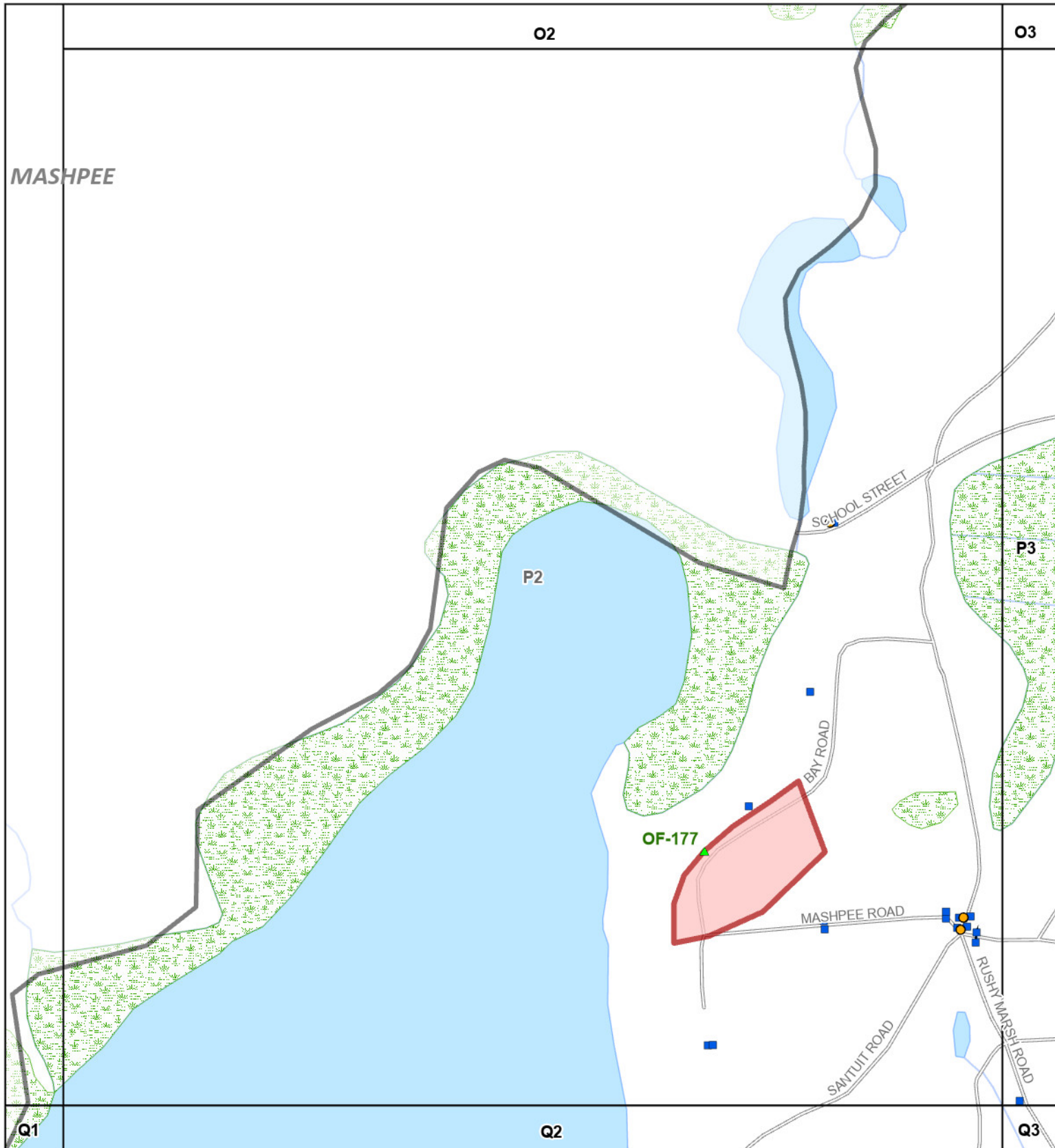
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| ● Drainage Manhole | — Storm Water Gravity Drain |
| ■ Stormwater BMP | — Swale |
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| ✚ Interconnections | — Non-Urban Area |
| ▲ DOT Outfall | |

Stormwater Infrastructure Map Barnstable, MA

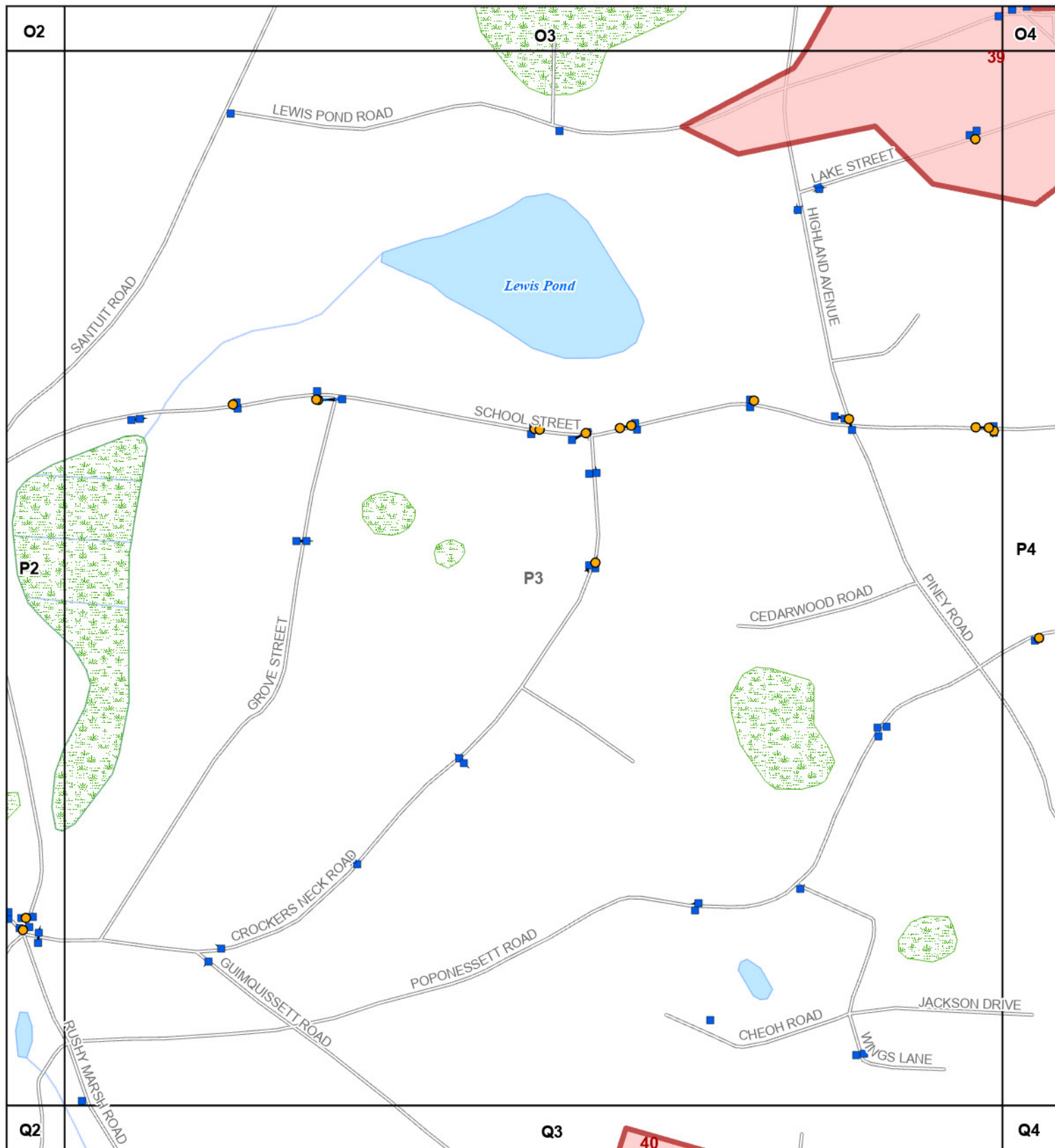
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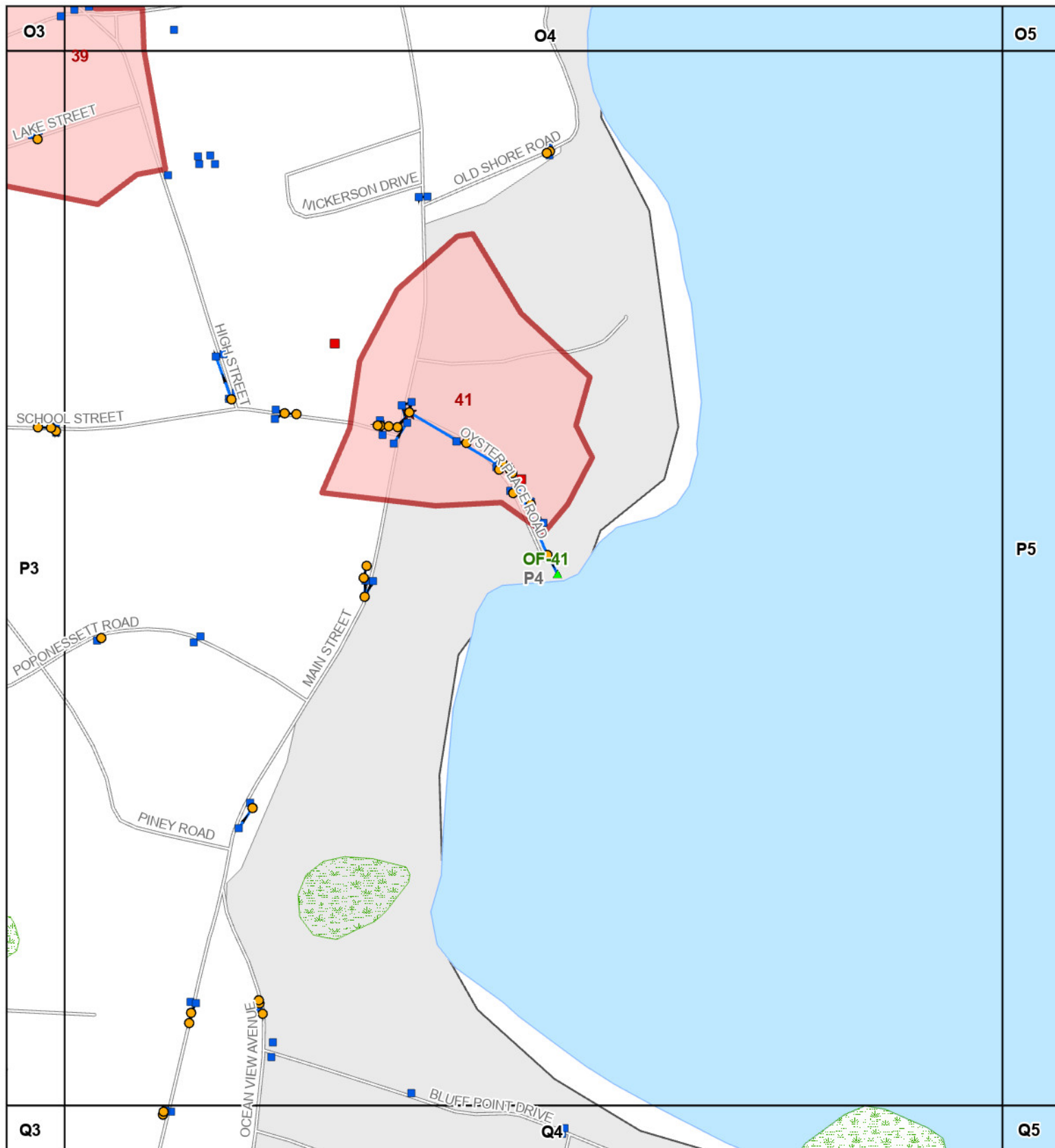
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| ● Drainage Manhole | — Storm Water Gravity Drain |
| ■ Stormwater BMP | — Swale |
| ★ Key Drainage Manhole | — Catchment |
| ✚ Interconnections | — Non-Urban Area |
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| ▲ Outfalls | ● DOT Manhole |
| ■ Catch Basin | ■ DOT Catch Basin |
| ● Drainage Manhole | — Storm Water Gravity Drain |
| ■ Stormwater BMP | — Swale |
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| ✚ Interconnections | — Non-Urban Area |
| ▲ DOT Outfall | |

Stormwater Infrastructure Map Barnstable, MA

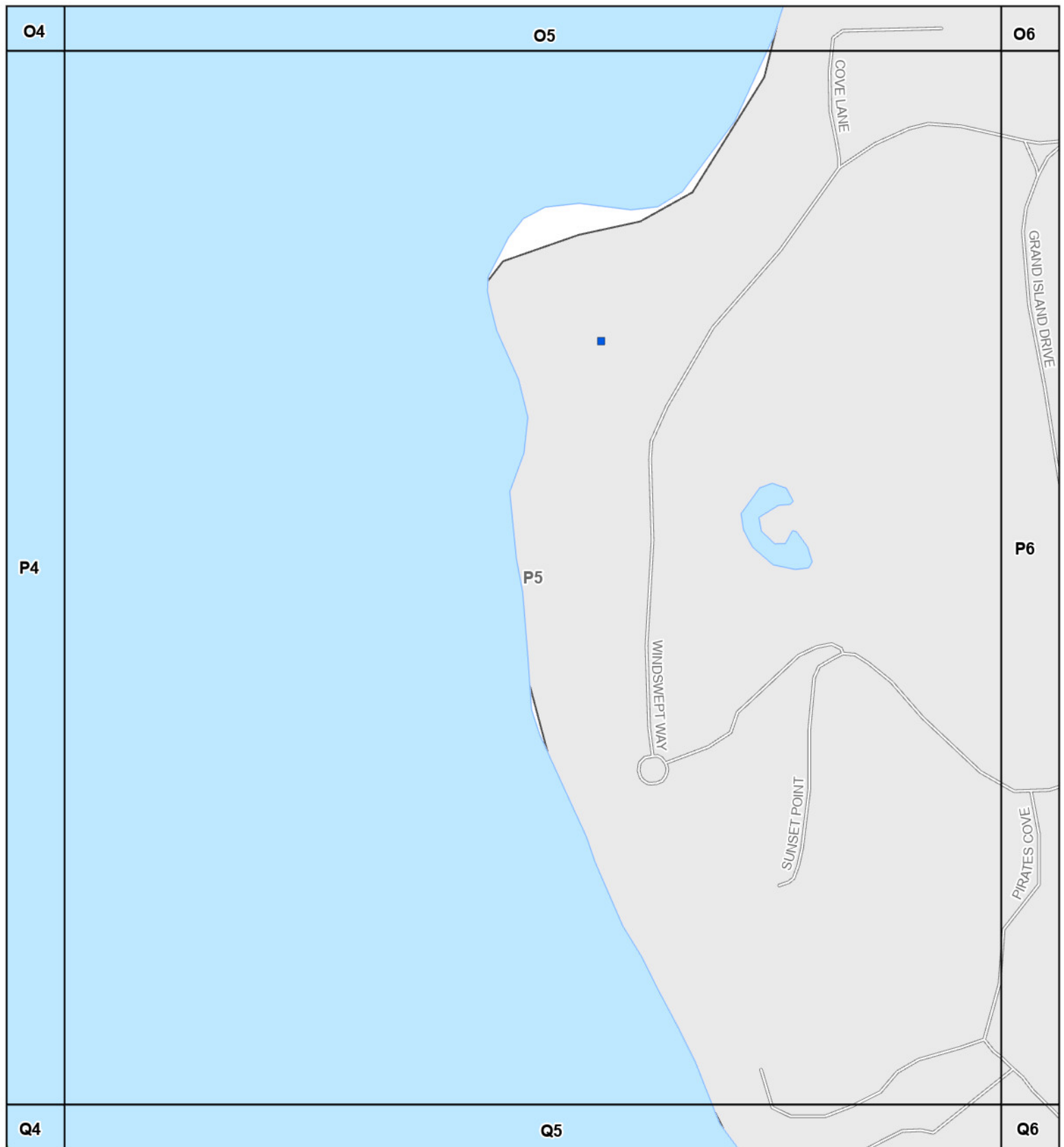
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| ■ Catch Basin | ■ DOT Catch Basin |
| ● Drainage Manhole | — Storm Water Gravity Drain |
| ■ Stormwater BMP | — Swale |
| ★ Key Drainage Manhole | — Catchment |
| ✚ Interconnections | — Non-Urban Area |
| ▲ DOT Outfall | |

Stormwater Infrastructure Map Barnstable, MA

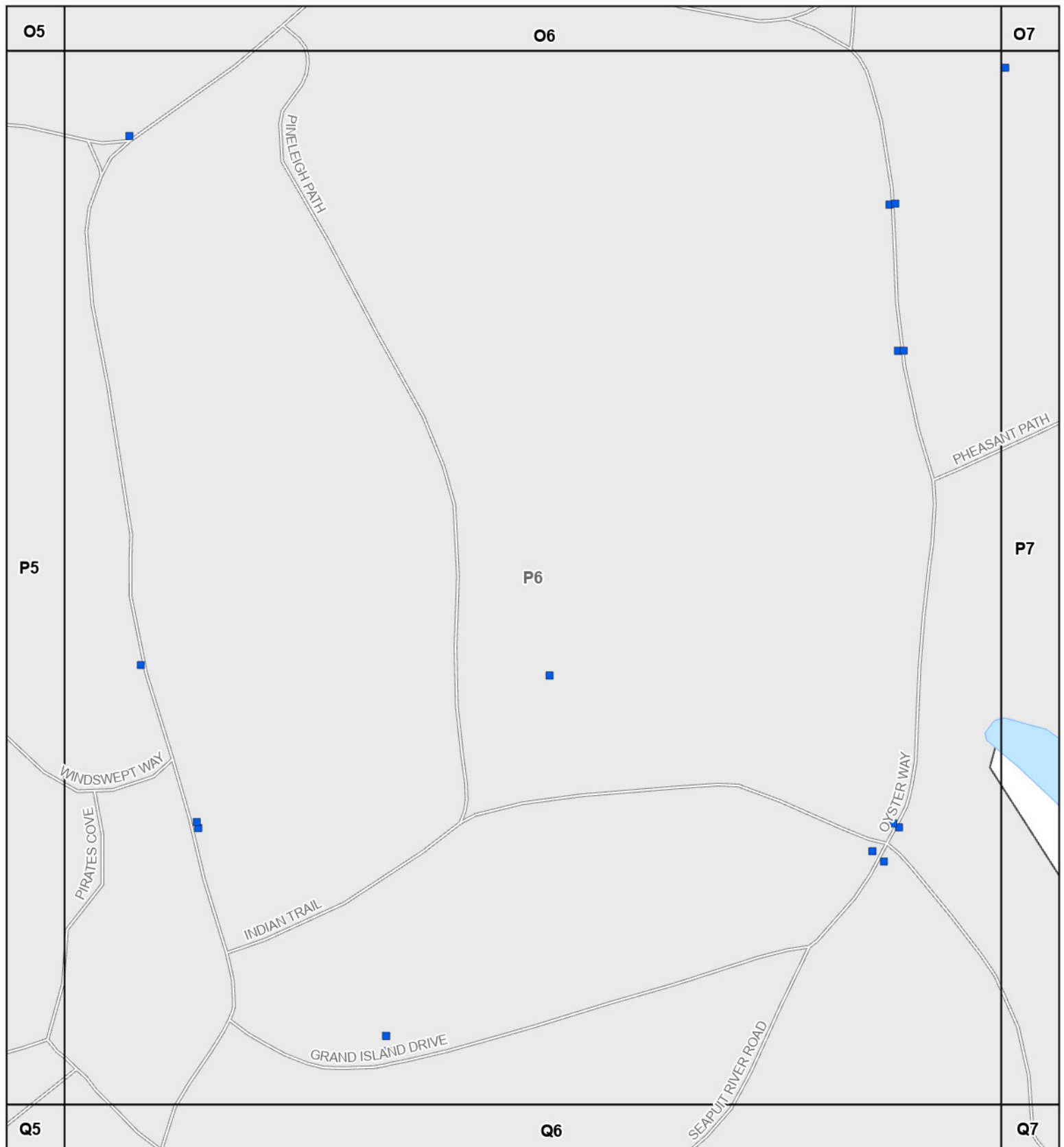
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| ● Drainage Manhole | — Storm Water Gravity Drain |
| ■ Stormwater BMP | — Swale |
| ★ Key Drainage Manhole | — Catchment |
| ✚ Interconnections | — Non-Urban Area |
| ▲ DOT Outfall | |

Stormwater Infrastructure Map Barnstable, MA

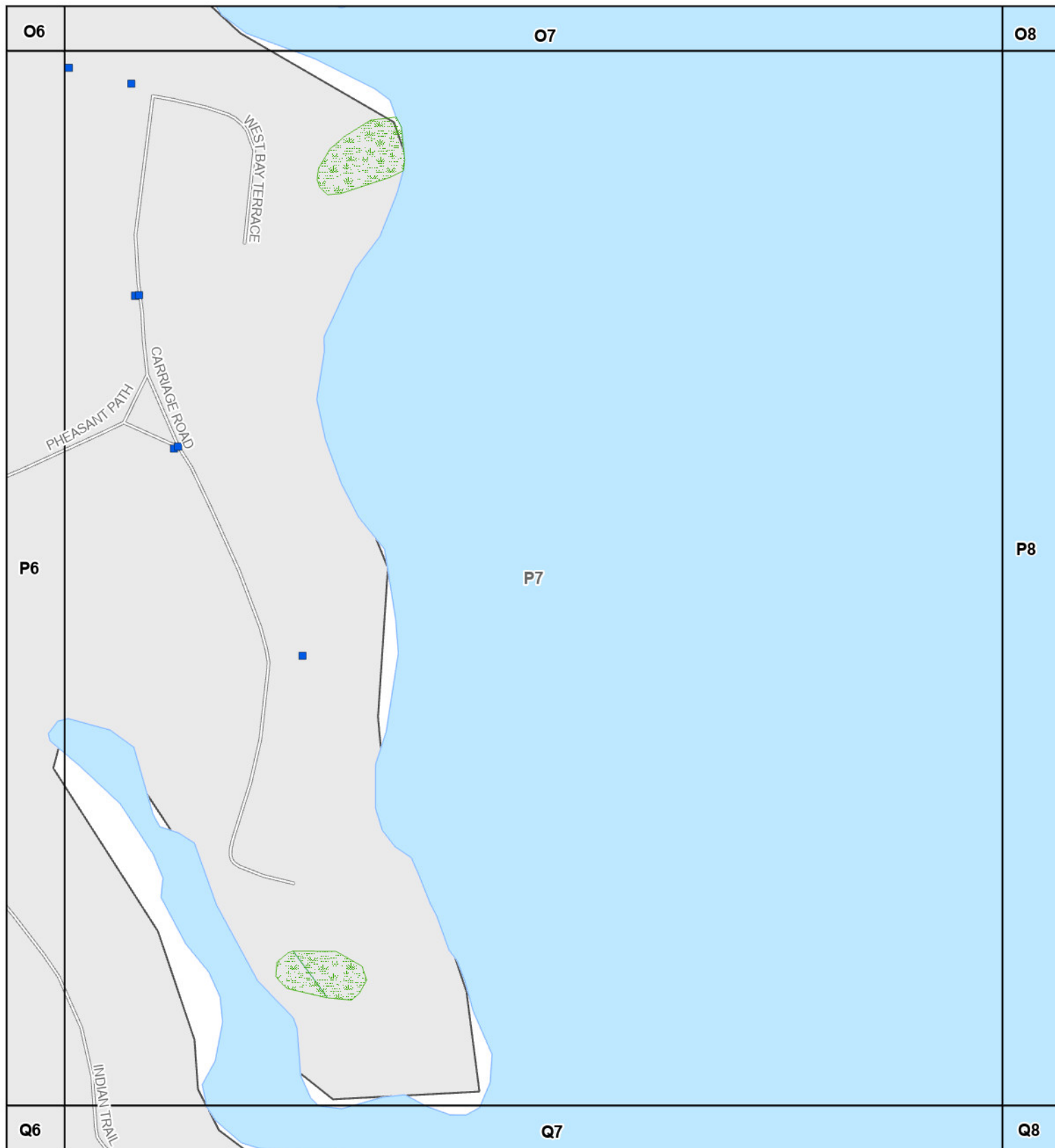
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| ● Drainage Manhole | — Storm Water Gravity Drain |
| ■ Stormwater BMP | — Swale |
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| ✚ Interconnections | — Non-Urban Area |
| ▲ DOT Outfall | |

Stormwater Infrastructure Map Barnstable, MA

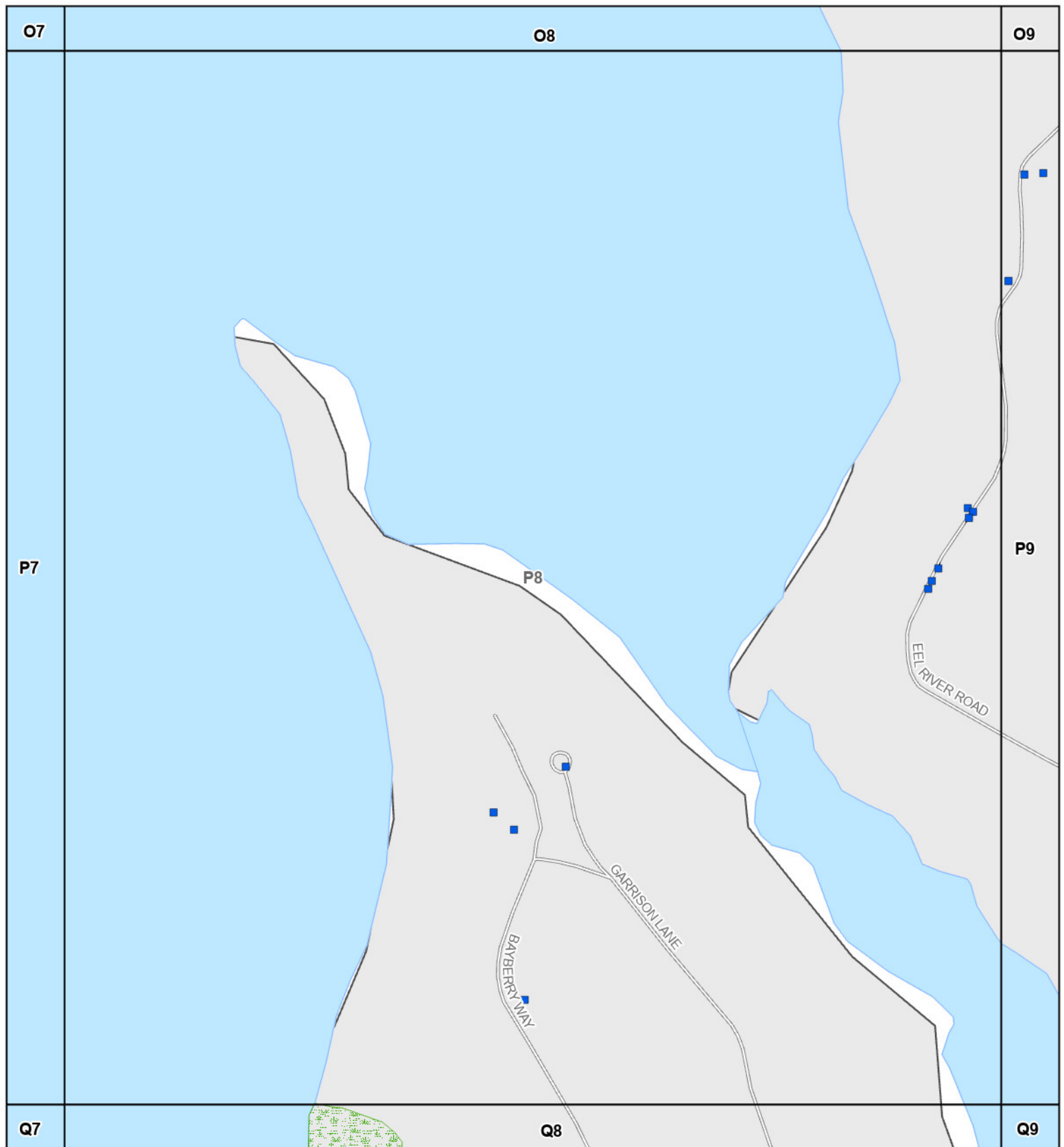
SHEET

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| ▲ Outfalls | ● DOT Manhole |
| ■ Catch Basin | ■ DOT Catch Basin |
| ● Drainage Manhole | — Storm Water Gravity Drain |
| ■ Stormwater BMP | — Swale |
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| ✚ Interconnections | — Non-Urban Area |
| ▲ DOT Outfall | |

Stormwater Infrastructure Map Barnstable, MA

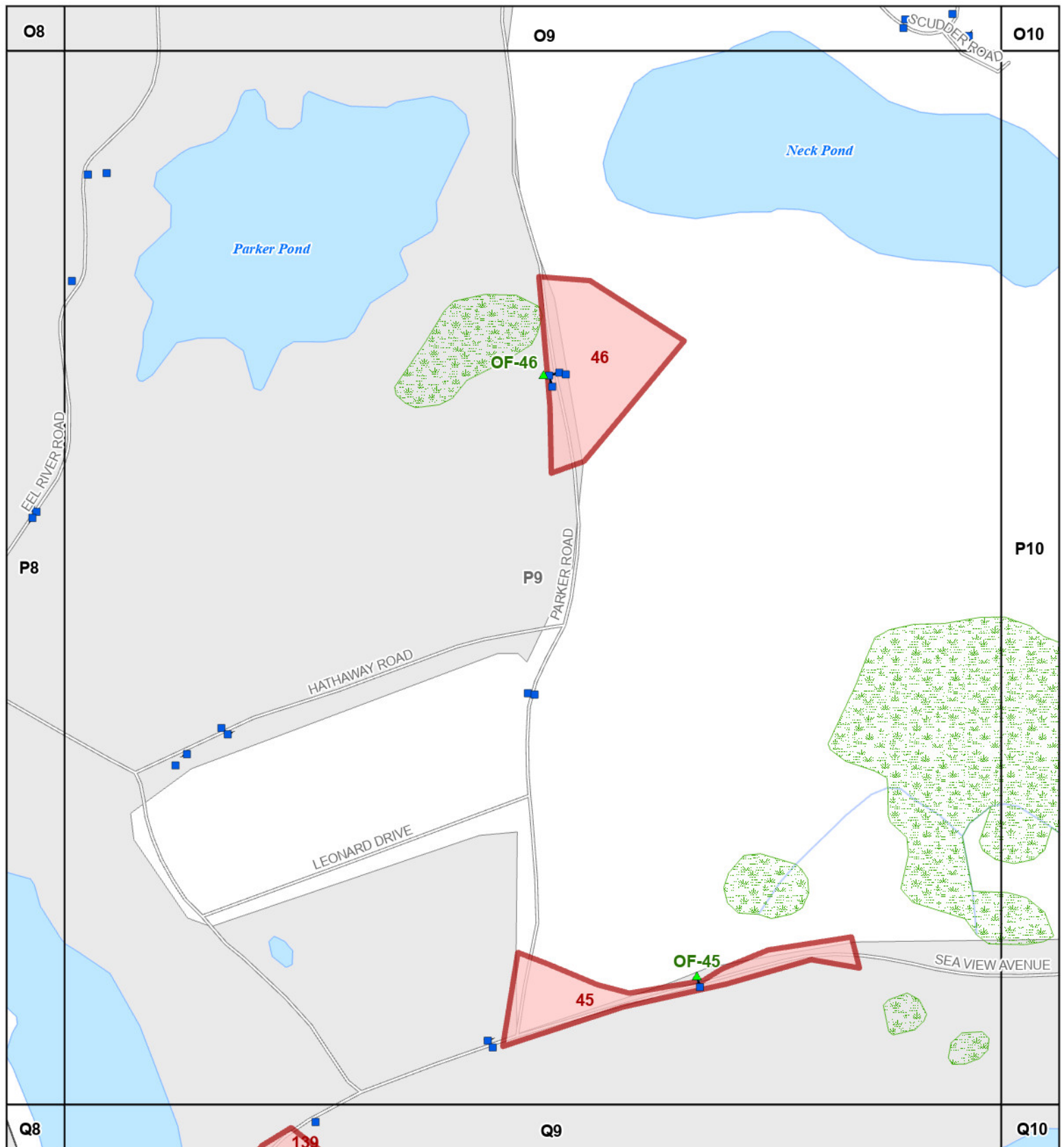
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| ● Drainage Manhole | — Storm Water Gravity Drain |
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| ★ Key Drainage Manhole | — Catchment |
| ✚ Interconnections | — Non-Urban Area |
| ▲ DOT Outfall | |

Stormwater Infrastructure Map Barnstable, MA

SHEET

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Feet



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| ▲ Outfalls | ● DOT Manhole |
| ■ Catch Basin | ■ DOT Catch Basin |
| ● Drainage Manhole | — Storm Water Gravity Drain |
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| ✚ Interconnections | — Non-Urban Area |
| ▲ DOT Outfall | |

Stormwater Infrastructure Map Barnstable, MA

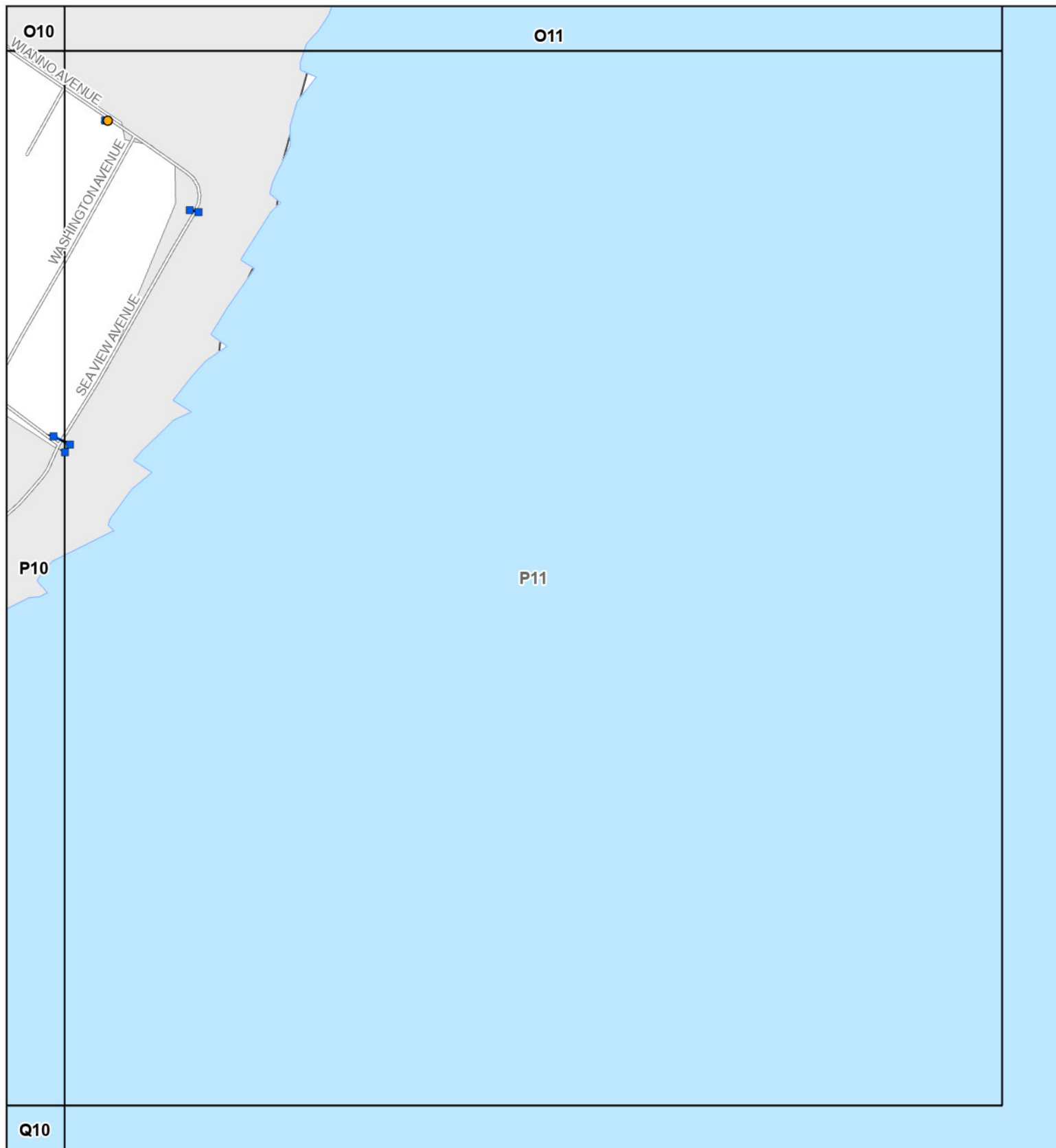
SHEET

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Environmental
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| ▲ Outfalls | ● DOT Manhole |
| ■ Catch Basin | ■ DOT Catch Basin |
| ● Drainage Manhole | — Storm Water Gravity Drain |
| ■ Stormwater BMP | — Swale |
| ★ Key Drainage Manhole | — Catchment |
| ✚ Interconnections | — Non-Urban Area |
| ▲ DOT Outfall | |

Stormwater Infrastructure Map Barnstable, MA

SHEET

P11

0 100 200 300 400 500
Feet



Comprehensive
Environmental
Incorporated

MASHPEE

P2

Q1

Q2

R1

R2

CLAMSHELL POINT LANE

CLAMSHELL COVE ROAD

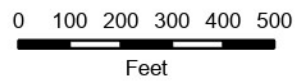
COTUIT COVE ROAD

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| ■ Stormwater BMP | — Swale |
| ★ Key Drainage Manhole | — Catchment |
| ✚ Interconnections | — Non-Urban Area |
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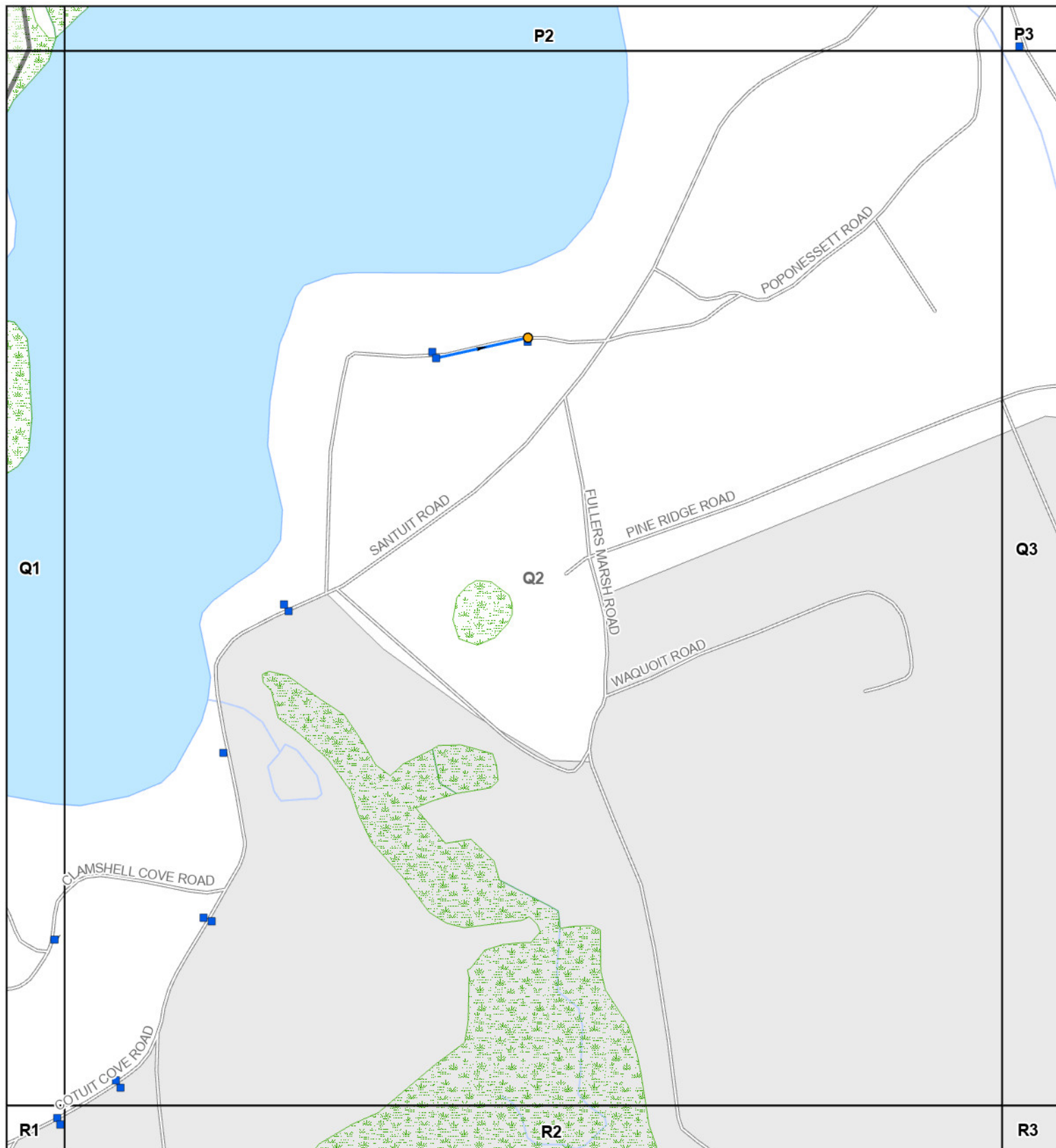
**Stormwater Infrastructure
Map
Barnstable, MA**

SHEET

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**Comprehensive
Environmental
Incorporated**



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| ▲ Outfalls | ● DOT Manhole |
| ■ Catch Basin | ■ DOT Catch Basin |
| ● Drainage Manhole | — Storm Water Gravity Drain |
| ■ Stormwater BMP | — Swale |
| ★ Key Drainage Manhole | — Catchment |
| ✚ Interconnections | — Non-Urban Area |
| ▲ DOT Outfall | |

Stormwater Infrastructure Map Barnstable, MA

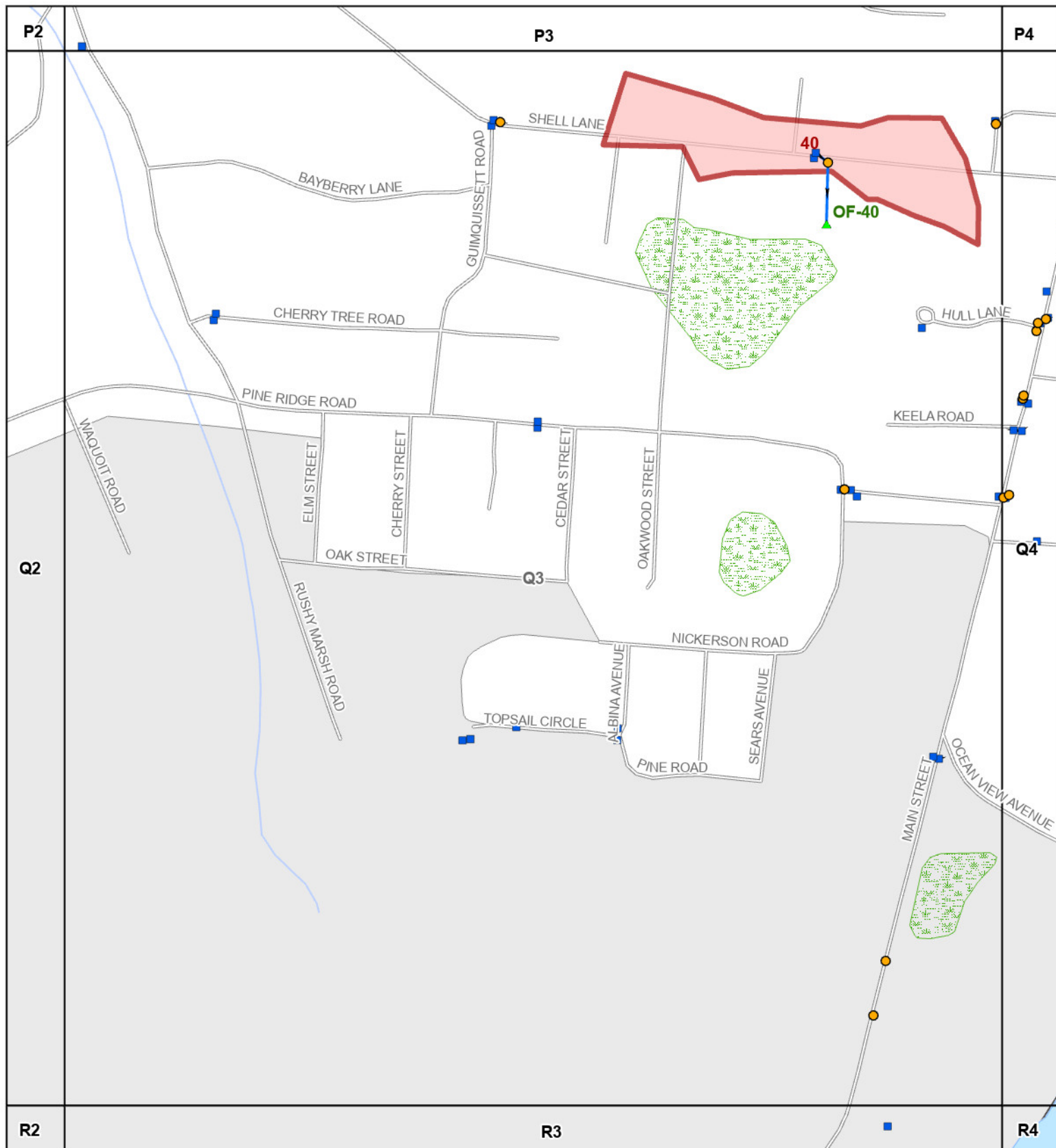
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Comprehensive
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| ■ Catch Basin | ■ DOT Catch Basin |
| ● Drainage Manhole | — Storm Water Gravity Drain |
| ■ Stormwater BMP | — Swale |
| ★ Key Drainage Manhole | — Catchment |
| ✚ Interconnections | — Non-Urban Area |
| ▲ DOT Outfall | |

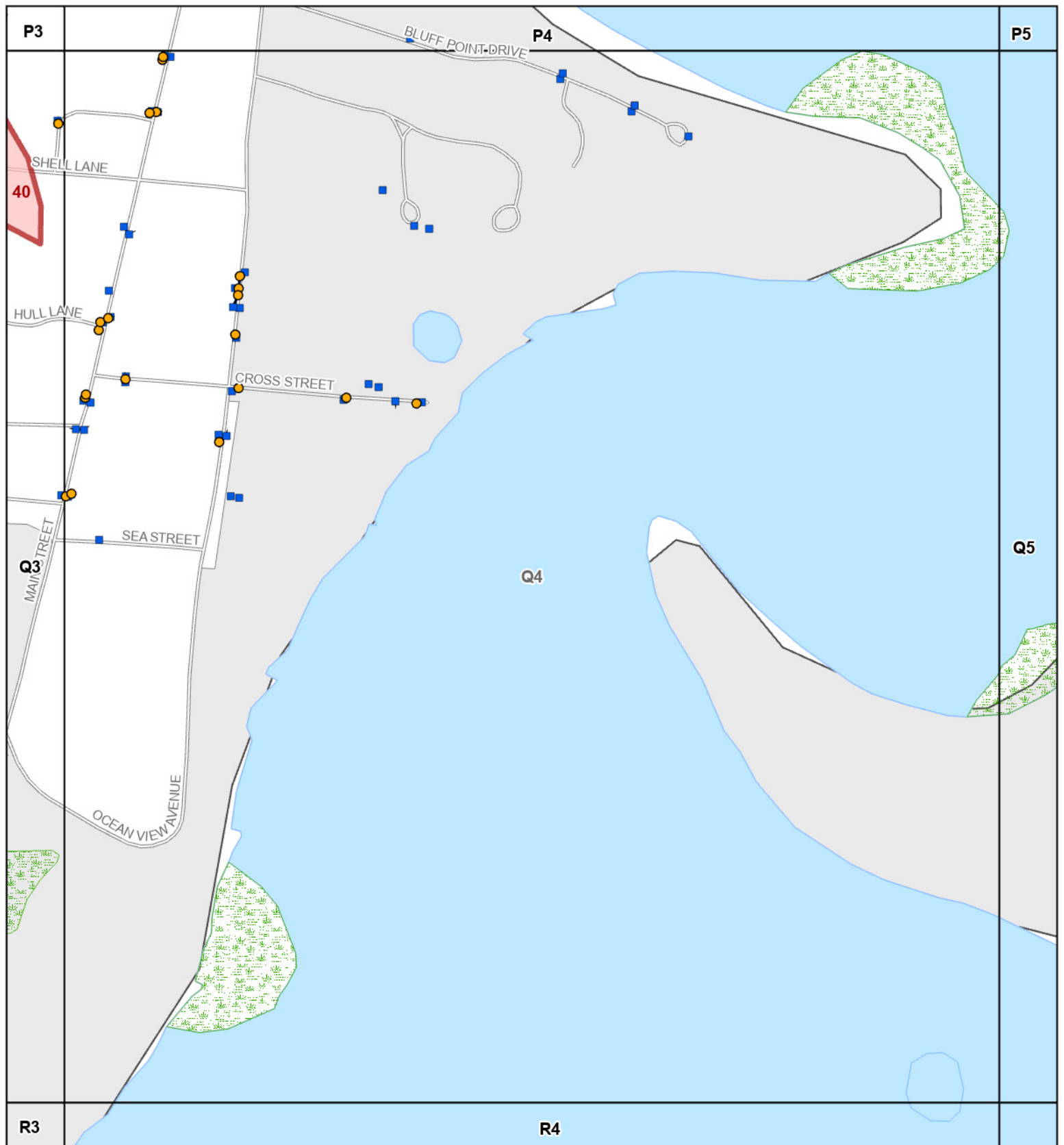
Stormwater Infrastructure Map Barnstable, MA

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Comprehensive
Environmental
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| ● Drainage Manhole | — Storm Water Gravity Drain |
| ■ Stormwater BMP | — Swale |
| ★ Key Drainage Manhole | — Catchment |
| ✚ Interconnections | — Non-Urban Area |
| ▲ DOT Outfall | |

Stormwater Infrastructure Map Barnstable, MA

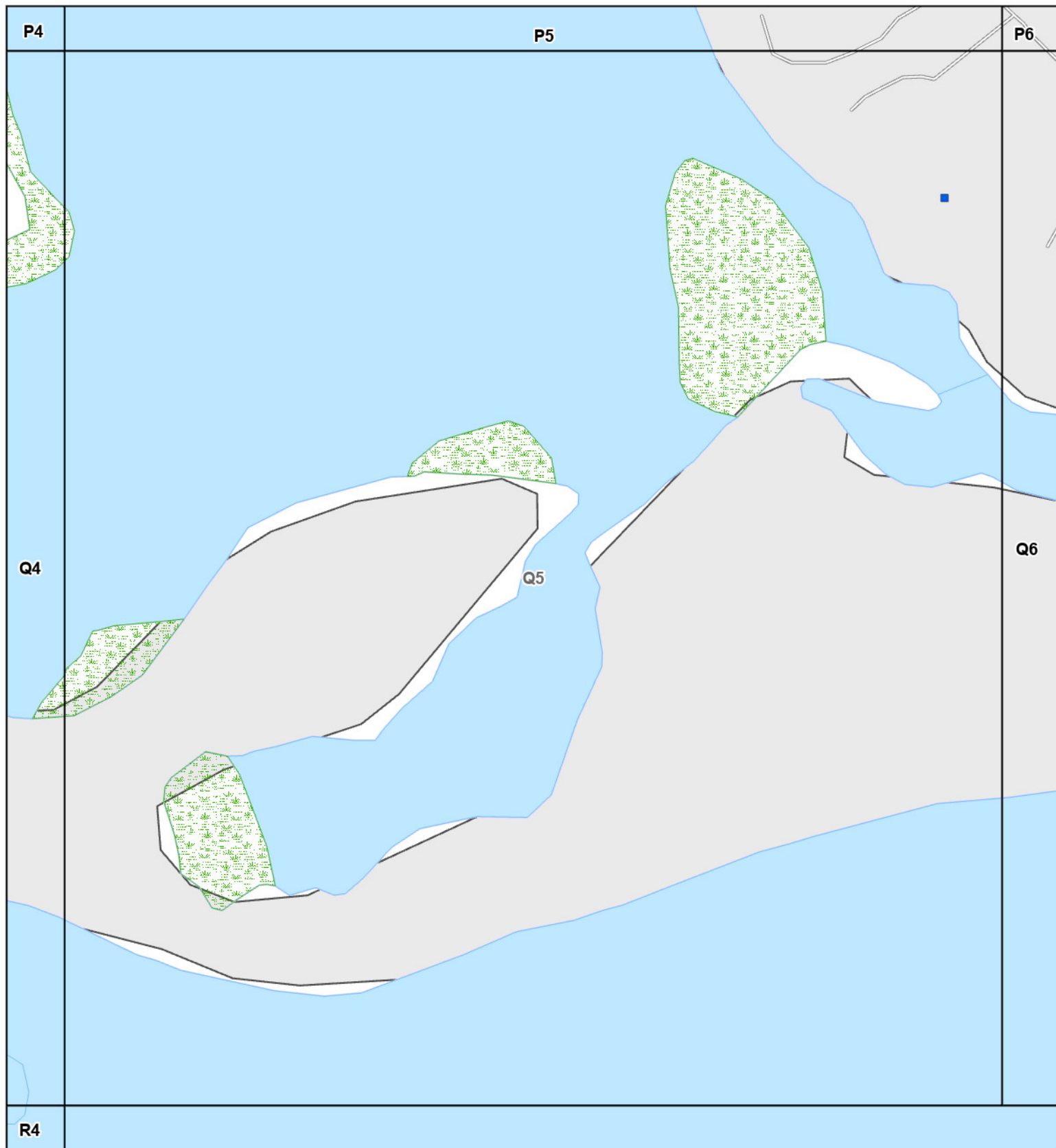
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Comprehensive
Environmental
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| ■ Catch Basin | ■ DOT Catch Basin |
| ● Drainage Manhole | — Storm Water Gravity Drain |
| ■ Stormwater BMP | — Swale |
| ★ Key Drainage Manhole | — Catchment |
| ✚ Interconnections | — Non-Urban Area |
| ▲ DOT Outfall | |

Stormwater Infrastructure Map Barnstable, MA

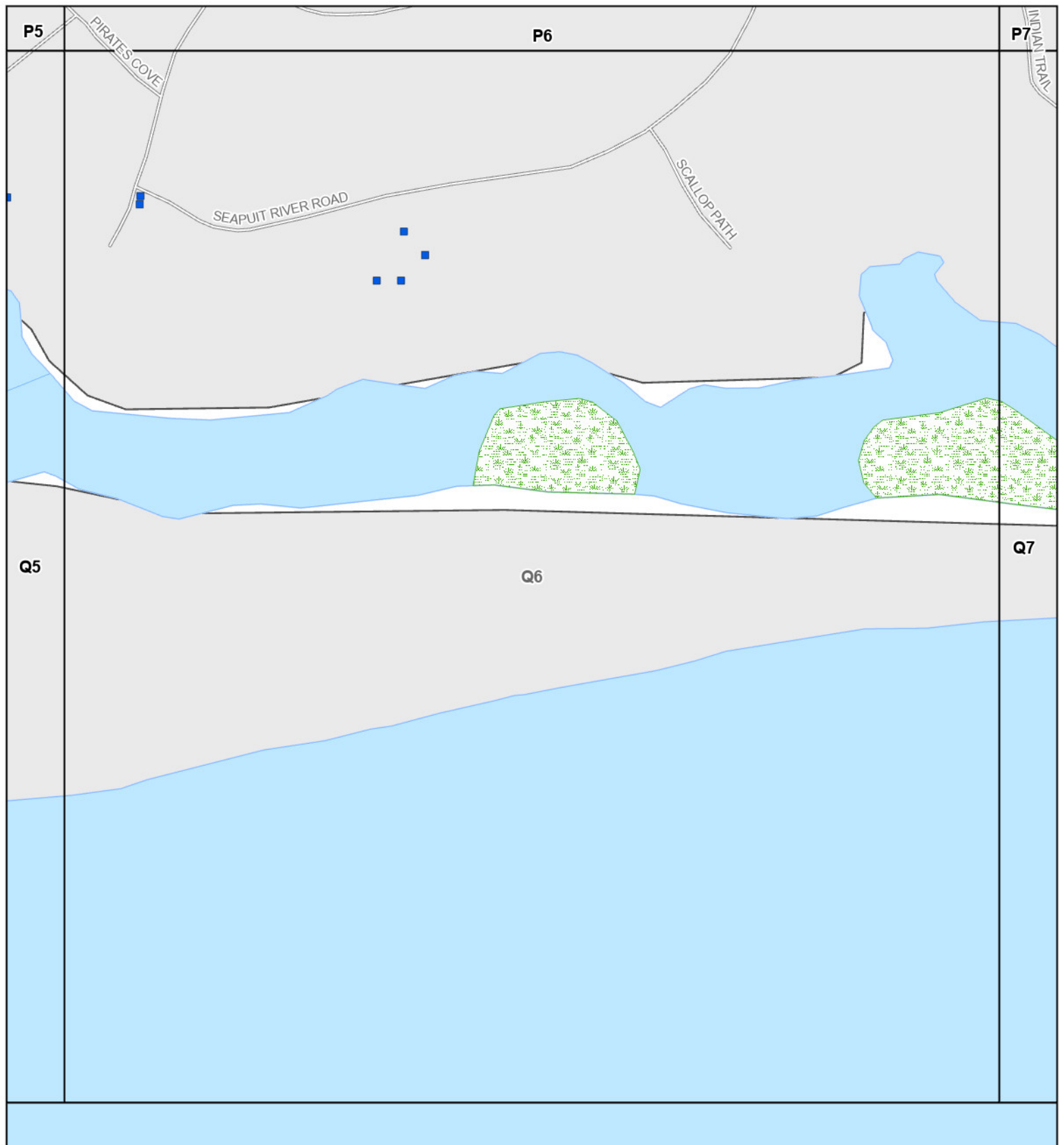
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Comprehensive
Environmental
Incorporated



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| ■ Catch Basin | ■ DOT Catch Basin |
| ● Drainage Manhole | — Storm Water Gravity Drain |
| ■ Stormwater BMP | ~ Swale |
| ★ Key Drainage Manhole | ☞ Catchment |
| ✚ Interconnections | ☁ Non-Urban Area |
| ▲ DOT Outfall | |

Stormwater Infrastructure Map Barnstable, MA

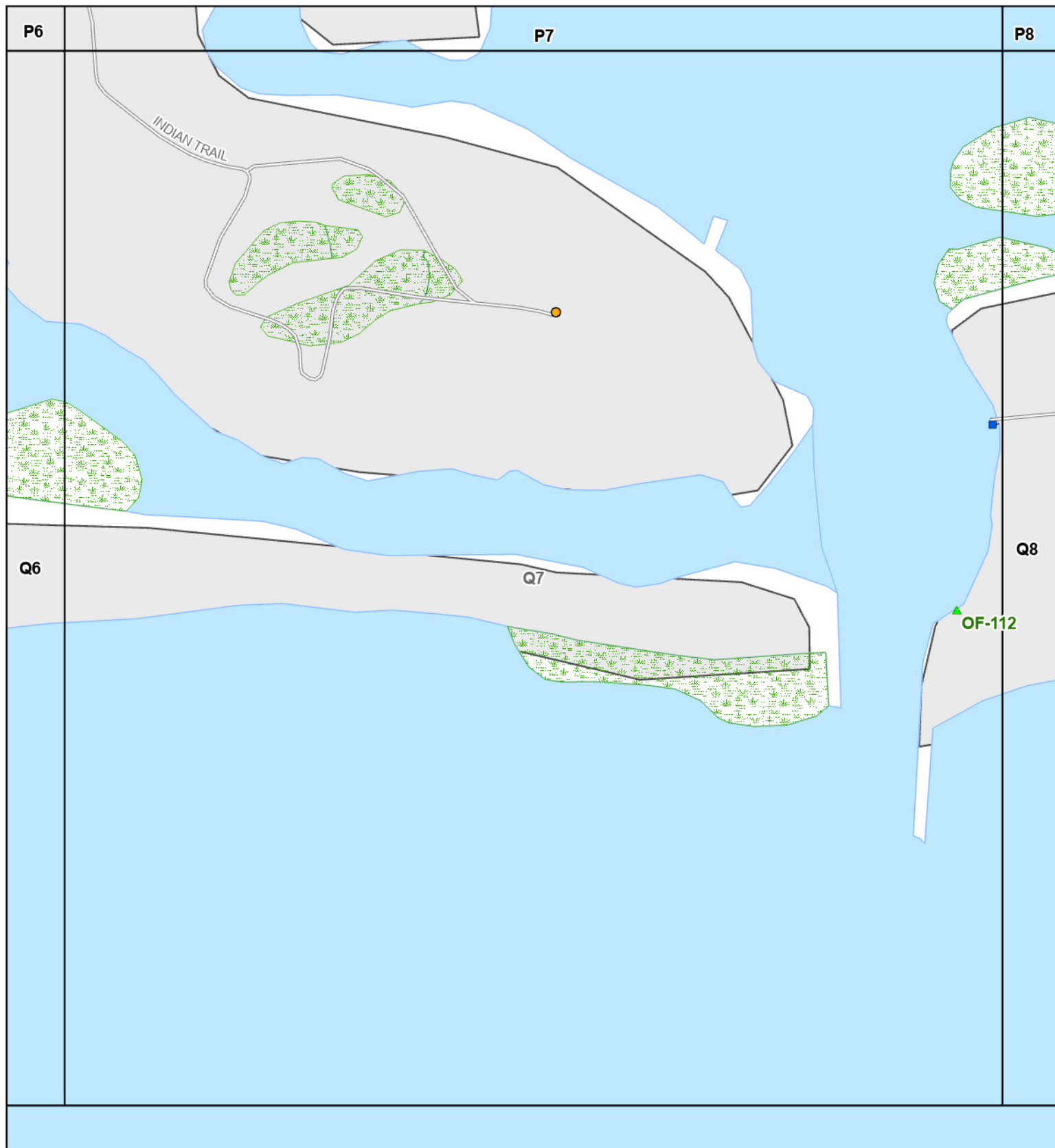
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Q6

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Feet



Comprehensive
Environmental
Incorporated



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|------------------------|-----------------------------|
| ▲ Outfalls | ● DOT Manhole |
| ■ Catch Basin | ■ DOT Catch Basin |
| ● Drainage Manhole | — Storm Water Gravity Drain |
| ■ Stormwater BMP | — Swale |
| ★ Key Drainage Manhole | — Catchment |
| ✚ Interconnections | — Non-Urban Area |
| ▲ DOT Outfall | |

Stormwater Infrastructure Map Barnstable, MA

SHEET

Q7

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Feet



Comprehensive
Environmental
Incorporated



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| ▲ Outfalls | ● DOT Manhole |
| ■ Catch Basin | ■ DOT Catch Basin |
| ● Drainage Manhole | — Storm Water Gravity Drain |
| ■ Stormwater BMP | — Swale |
| ★ Key Drainage Manhole | — Catchment |
| ✚ Interconnections | — Non-Urban Area |
| ▲ DOT Outfall | |

Stormwater Infrastructure Map Barnstable, MA

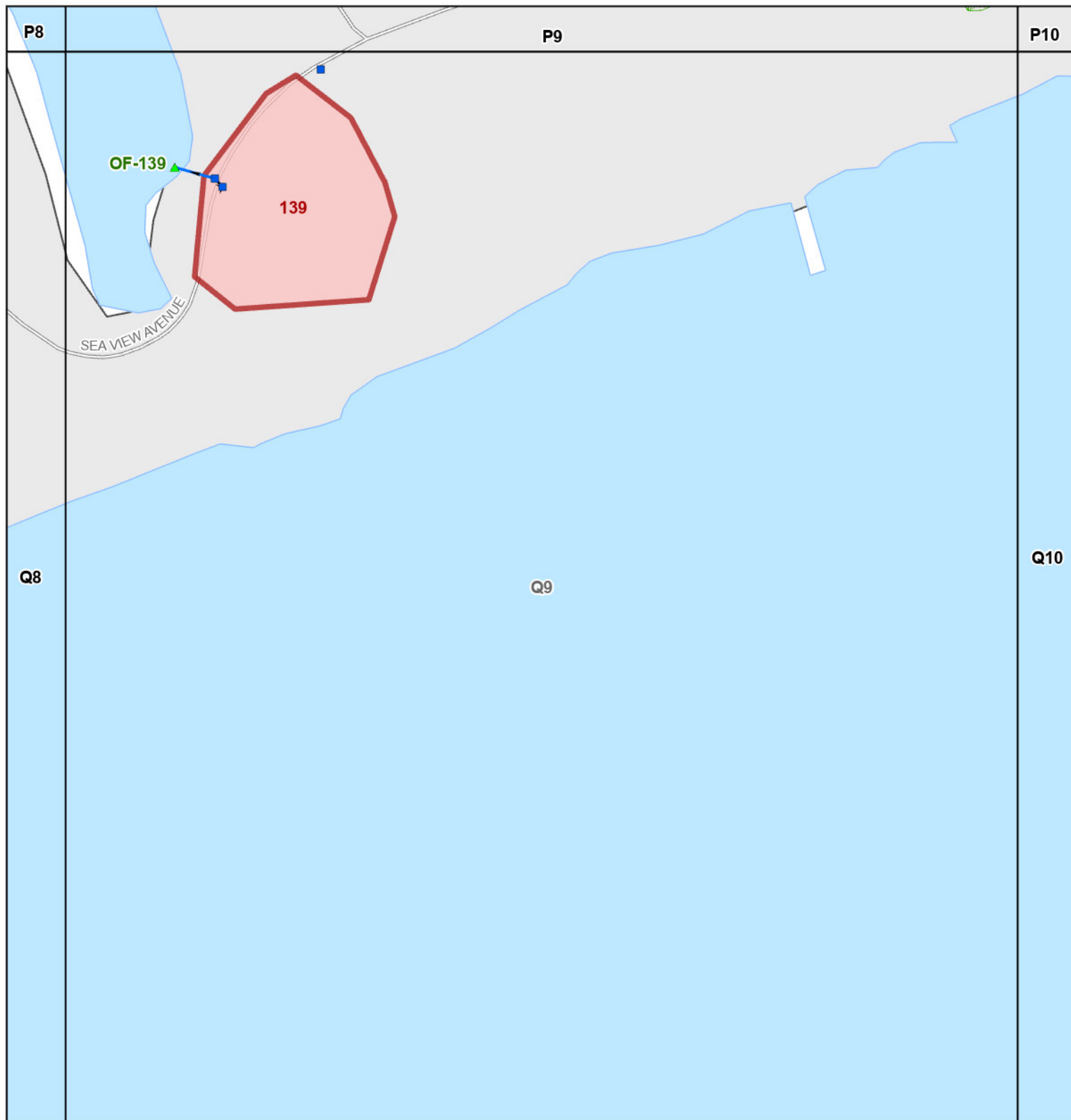
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Feet



Comprehensive
Environmental
Incorporated



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| ▲ Outfalls | ● DOT Manhole |
| ■ Catch Basin | ■ DOT Catch Basin |
| ● Drainage Manhole | — Storm Water Gravity Drain |
| ■ Stormwater BMP | — Swale |
| ★ Key Drainage Manhole | — Catchment |
| ✚ Interconnections | — Non-Urban Area |
| ▲ DOT Outfall | |

Stormwater Infrastructure Map Barnstable, MA

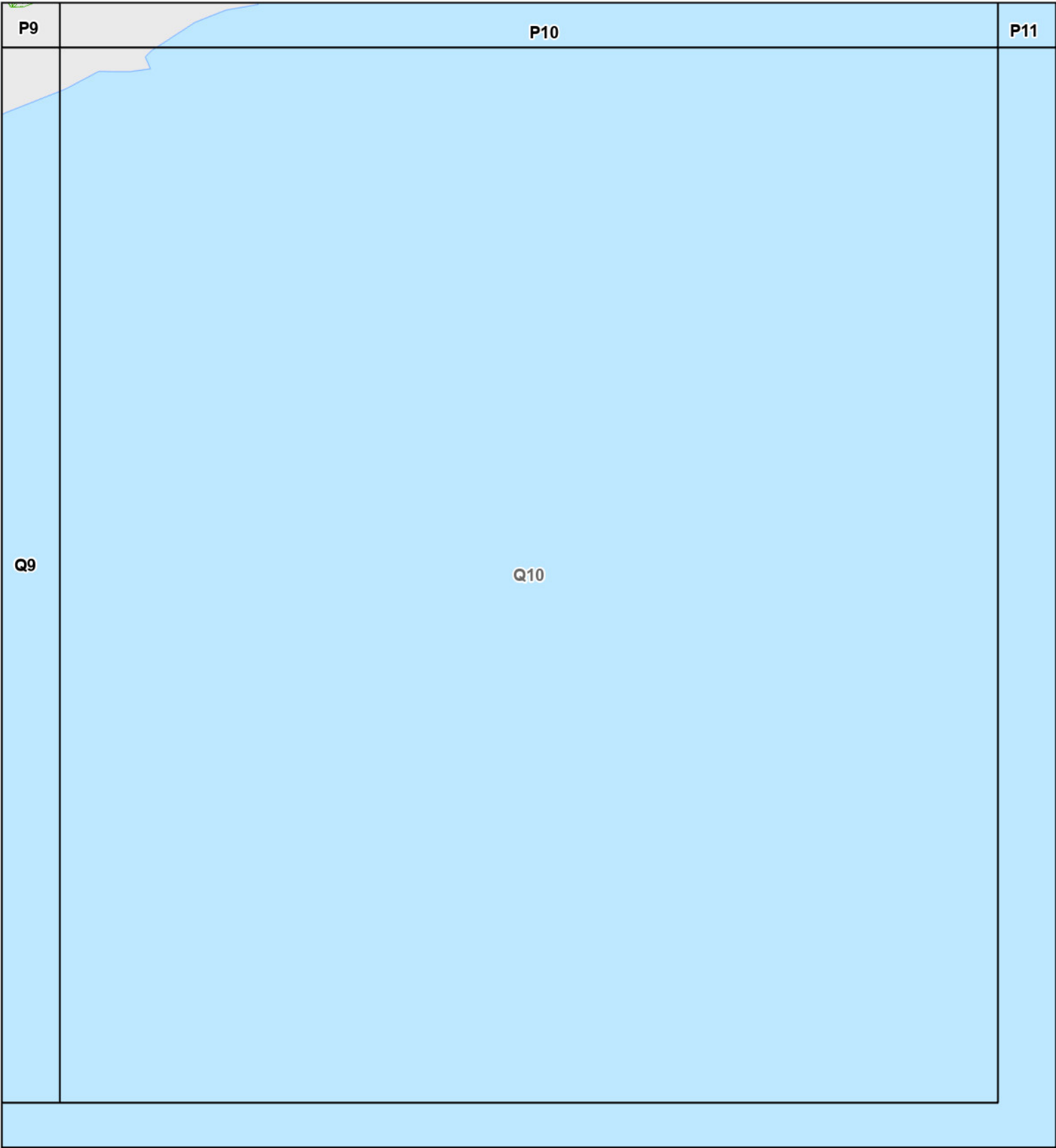
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Q9

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Environmental
Incorporated

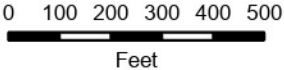


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| ▲ Outfalls | ● DOT Manhole |
| ■ Catch Basin | ■ DOT Catch Basin |
| ● Drainage Manhole | — Storm Water Gravity Drain |
| ■ Stormwater BMP | — Swale |
| ★ Key Drainage Manhole | — Catchment |
| ✚ Interconnections | — Non-Urban Area |
| ▲ DOT Outfall | |

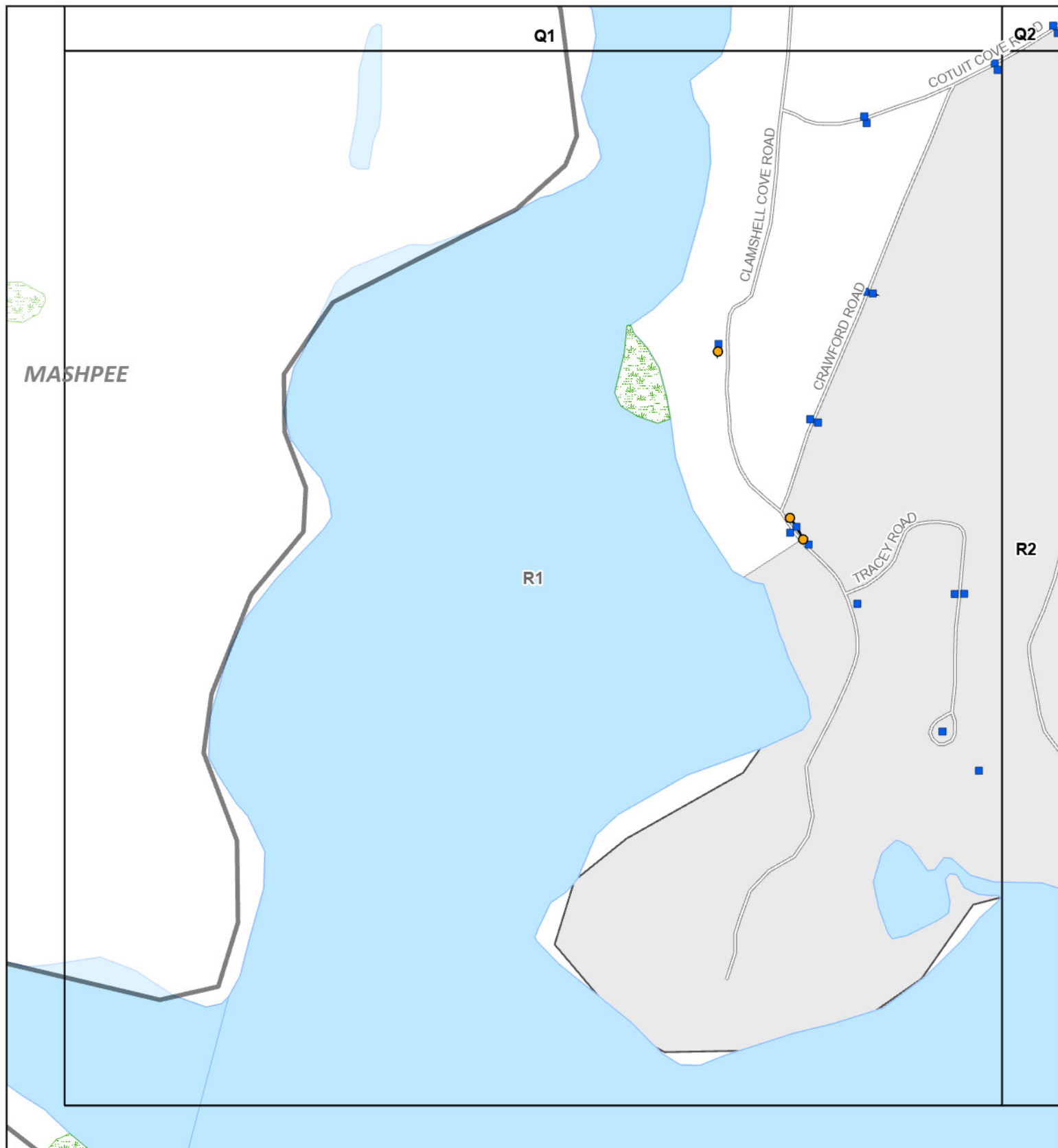
Stormwater Infrastructure Map Barnstable, MA

SHEET

Q10



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Incorporated**



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| ▲ Outfalls | ● DOT Manhole |
| ■ Catch Basin | ■ DOT Catch Basin |
| ● Drainage Manhole | — Storm Water Gravity Drain |
| ■ Stormwater BMP | ~ Swale |
| ★ Key Drainage Manhole | ○ Catchment |
| ✚ Interconnections | ■ Non-Urban Area |
| ▲ DOT Outfall | |

Stormwater Infrastructure Map Barnstable, MA

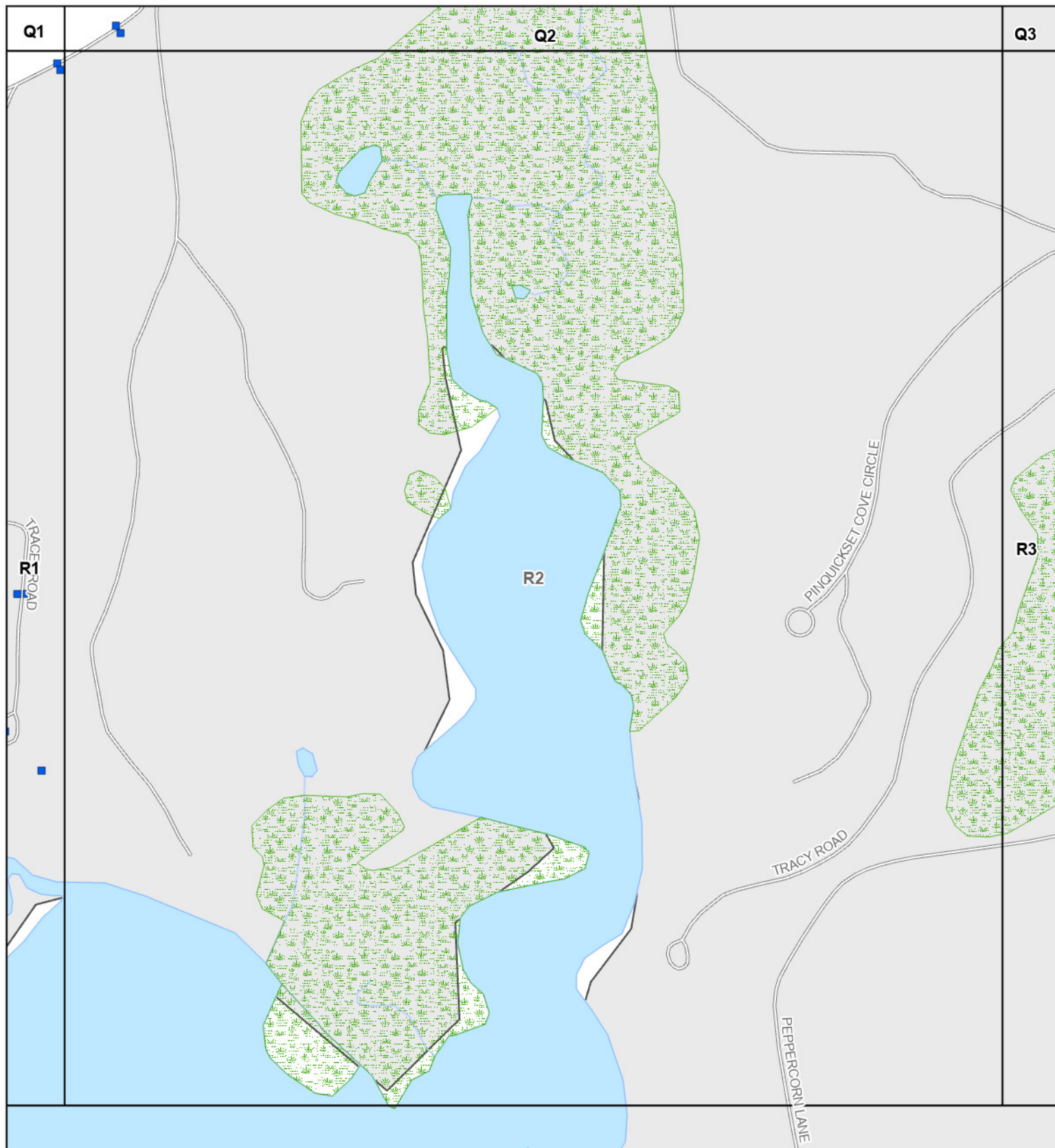
SHEET

R1

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Feet



Comprehensive
Environmental
Incorporated



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| ▲ Outfalls | ● DOT Manhole |
| ■ Catch Basin | ■ DOT Catch Basin |
| ○ Drainage Manhole | — Storm Water Gravity Drain |
| ■ Stormwater BMP | — Swale |
| ★ Key Drainage Manhole | — Catchment |
| ✚ Interconnections | — Non-Urban Area |
| ▲ DOT Outfall | |

Stormwater Infrastructure Map Barnstable, MA

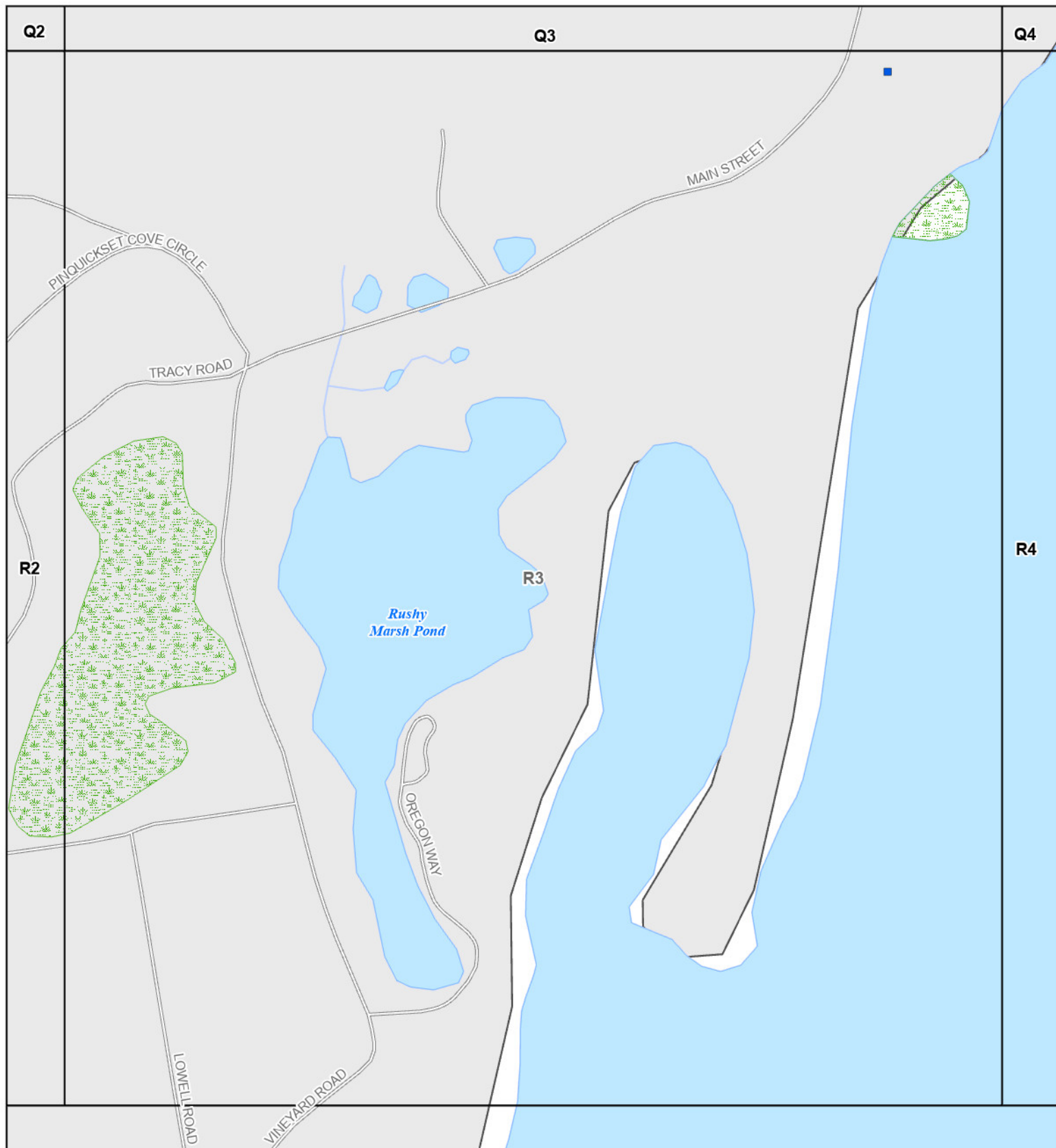
SHEET

R2

0 100 200 300 400 500
Feet



Comprehensive
Environmental
Incorporated



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| ▲ Outfalls | ● DOT Manhole |
| ■ Catch Basin | ■ DOT Catch Basin |
| ● Drainage Manhole | — Storm Water Gravity Drain |
| ■ Stormwater BMP | — Swale |
| ★ Key Drainage Manhole | — Catchment |
| ✚ Interconnections | — Non-Urban Area |
| ▲ DOT Outfall | |

Stormwater Infrastructure Map Barnstable, MA

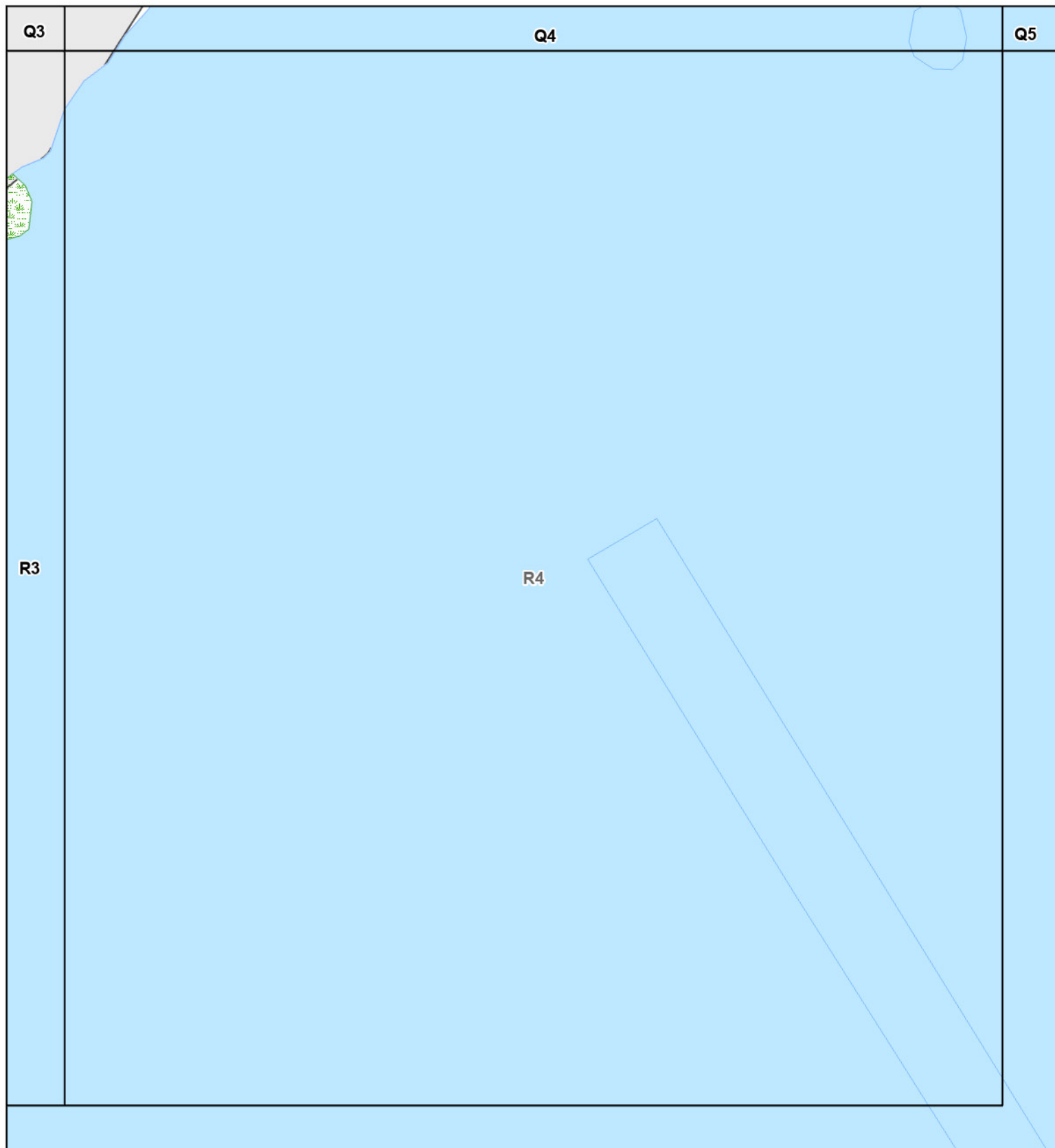
SHEET

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Environmental
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| ▲ Outfalls | ● DOT Manhole |
| ■ Catch Basin | ■ DOT Catch Basin |
| ● Drainage Manhole | — Storm Water Gravity Drain |
| ■ Stormwater BMP | — Swale |
| ★ Key Drainage Manhole | — Catchment |
| ✚ Interconnections | — Non-Urban Area |
| ▲ DOT Outfall | |

Stormwater Infrastructure Map Barnstable, MA

SHEET
R4

0 100 200 300 400 500
Feet



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Appendix B

SSO Inventory

Sanitary Sewer Overflow Inventory

SSO Location ¹	Discharge Statement ²	Date & Time Start ³	Date & Time End ³	Date & Time Reported ³	Estimated Volume ⁴	Description of SSO, Expected Source and Cause ⁵	Mitigation Completed ⁶	Mitigation Planned ⁷
86 Seabrook Road, Hyannis MA 02601	SSO discharged to a ground surface. No release to surface water.	4/29/2015 3:00 PM	4/30/2015 3:00 PM	4/30/2015 9:30 AM	>2000 gallons	Upon notification of the SSO from a neighboring resident, Water Pollution Control Staff identified a failed roadside sewer connection. The pressurized sewer line was not properly sealed by the contractor and gave way.	Bortolotti Construction was contracted to dig down, repair the connection, and add a new curb stop.	N/A - Full mitigation achieved
Kalmus Beach beachhouse pump station	SSO discharged to a ground surface. No release to surface water.	6/9/2015 3:00 PM	6/9/2015 5:00 PM	6/9/2015 3:00 PM	30 gallons	WPCD staff was notified by beach house attendants of wastewater coming out of a manhole at the Kalmus Beach beach house. The overflow was caused by a pump station failure at the beach house.	WPCD staff contacted a septic hauler to pump out the valve pit that had become flooded. Once the pit was pumped down, WPCD staff fixed the issue with the discharge valve and service was restored.	N/A - Full mitigation achieved
352 Ocean Street, Hyannis MA 02601	SSO discharged to a ground surface. No release to surface water.	11/23/2016 7:40 AM	11/23/2016 9:00 AM	11/23/2016 11:00 AM	50-100 gallons	Upon notification from a neighboring resident, WPCD staff identified an automatic air relief valve failure as the cause of the SSO, which was discharging from the sewer force main from the air relief valve manhole.	Upon arrival WPCD staff was able to locate a nearby gravity manhole to pump out the air relief manhole. WPCD Staff then closed the isolation valve to the air relief valve in order to prevent this from occurring again.	
490 Independence Drive Hyannis MA, 02601	SSO discharged to a ground surface. No release to surface water.	8/8/2017 1:30 PM	8/8/2017 1:50 PM	8/8/2017 3:30 PM	500 gallons	Pooled sewage was spotted by the Hyannis Water Department on the ground surface near the pump station. Both sewage pumps at the station were clogged with rags and were tripped on overload.	The area where sewage had puddled up was cleaned using a vacuum truck, then hosed down with water and the area was then disinfected with a dilute sodium hypochlorite solution.	N/A - Full mitigation achieved
Catch basin at 47 Bay Shore Road, which discharges at 86 Bayshore Road (town landing)	SSO discharged to a catch basin and then to a receiving water (Lewis Bay)	7/9/2018 1:50 PM	7/10/2018	7/10/2018 9:37	<500 gallons	WPCD staff was notified of the SSO by a private resident at 39 Bayshore Road. The sewer system on their property was blocked up by a root intrusion.	WPCD staff vacuum cleaned the SSO puddle and the affected catch basin. The homeowner was instructed to reduce water usage. No leakage was reported on the morning of July 10. Area was dig-safed by a contractor.	Contractor who provided dig-safe to clear the roots and then fix the pipe leak by the end of the day on July 10.
600 feet northwest of the BJs entrance on Attucks Lane, Barnstable	SSO discharged to a ground surface. No release to surface water.	9/27/2018 12:30 PM	9/27/2018 1:30 PM	9/27/2018 3:00 PM	1000-2000 gallons	Upon notification of a possible water main break and sewage smell by a passerby, WPCD identified the source as the private sewer line coming from the BJs property. Cause was identified as a ruptured PVC force main.	Property manager was instructed to turn off the pump and transport sewage via pump truck. Pipe will require excavation and repairs and area needs to be disinfected.	Contractor notified WPCD that repairs were complete on September 28.

¹ Location (approximate street crossing/address and receiving water, if any)

² A clear statement of whether the discharge entered a surface water directly or entered the MS4

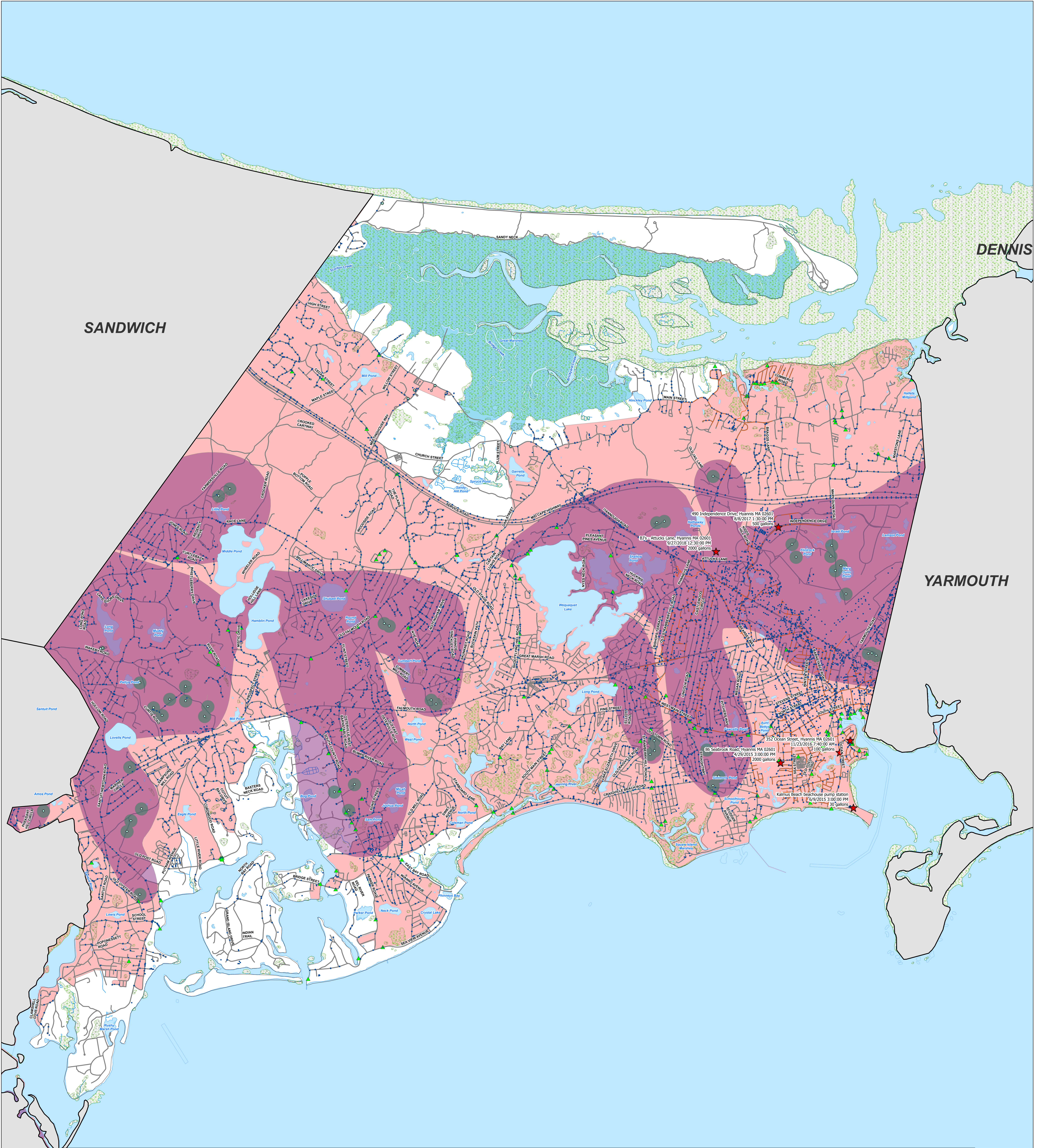
³ Date and time of each known SSO occurrence (i.e., beginning and end of any known discharge)

⁴ Estimated volume or quantity of the occurrence

⁵ Description of the occurrence indicating known or suspected cause(s)

⁶ Mitigation and corrective measures taken to minimize volume and duration of bypass with completed with dates implemented

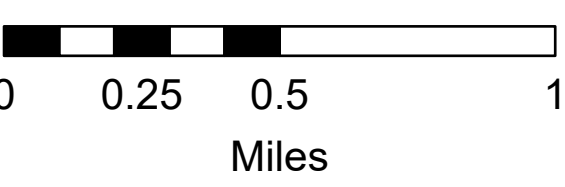
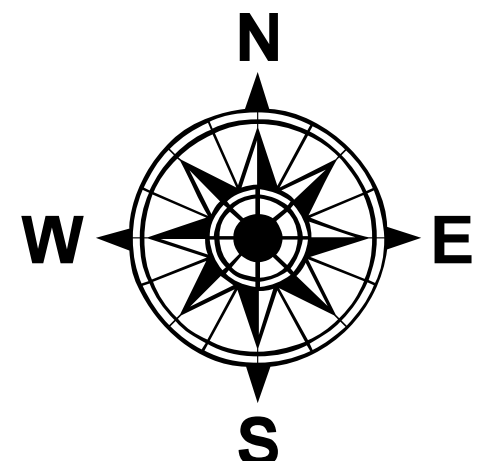
⁷ Mitigation and corrective measures planned with implementation schedules



Legend

- | | |
|---------------------------|-----------------------------------|
| Outfalls | Public Water Supply Wells |
| Catch Basins | Zone I Wellhead Protection Areas |
| Storm Water Gravity Drain | Zone II Wellhead Protection Areas |
| Urbanized Area | Sewer Lines |
| Roads | Sanitary Sewer Overflows |

- Hydrography**
- Lake, Pond, Reservoir
 - Wetland, Marsh, Swamp
 - Stream, Brook



**Stormwater Map with Past
Sanitary Sewer Overflows
Barnstable, MA**

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Data Sources: CEI, MassGIS, Town of Barnstable

Appendix C

IDDE Outfall Classification/Ranking & Vulnerability Assessment

Outfall Data						Sampling Data							Problem Outfalls		High Priority Outfalls										Excluded		Ranking		Notes							
Outfall ID	Receiving Water	Receiving Water Impairment ¹	Ammonia ≥ 0.5 mg/L, surfactants ≥ 0.25 mg/L, and bacteria > WQ criteria	Ammonia > 0.5 mg/L, surfactants > 0.25 mg/L, and detectable levels of chlorine	Ammonia > 0.5 mg/L	Surfactants > 0.25 mg/L	Chlorine > 0 mg/L	Bacteria > WQ criteria	Sewer odor detected during inspection	Known or suspected contributions of illicit discharges	Olfactory or visual evidence of sewage	Discharge to/near public beach	Discharge to/near recreational area	Discharge to/near drinking water supply	Discharge to/near shellfish beds	Past Discharge Complaints	Density of Generating Sites ²						Age of development Sewer areas >40 years old		Catchment areas serviced by septic systems converted to sewer	Historic combined sewer system that has been separated	Density of septic systems ≥30 years old in residential land use	Culverted stream lengths greater than a simple roadway crossing	Discharge to impaired water & potential to carry that pollutant	Presence of older industrial operations	Roadway drainage in undeveloped areas with no dwellings and no sanitary sewers	Outfall is drainage for athletic fields, parks or undeveloped green space & associated parking without services	Cross-country drainage alignments through undeveloped land	Overall Ranking (Problem, High, Low, Excluded)	Ranking Score (Number of boxes Checked)	Notes
OF-1	Hyannis Inner Harbor	FC, TN			x	x							x									x				x						High	2			
OF-2	Hyannis Inner Harbor	FC, TN											x									x				x						High	5	Town Way to Water		
OF-3	Hyannis Inner Harbor	FC, TN											x									x				x						High	3	Town Way to Water		
OF-4	Hyannis Inner Harbor	FC, TN																				x				x						High	2			
OF-5	Unnamed wetlands on Old Colony nr McKeon Park																																Low	0		
OF-6	Unnamed wetlands on Old Colony nr McKeon Park																					x											High	1		
OF-7	Unnamed wetlands on Old Colony nr McKeon Park																					x											High	1		
OF-8																																		Low	0	
OF-9																																		Low	0	
OF-10	Halls Creek	FC												x												x							High	3	Zone II; Hyannisport Country Club and Golf Course	
OF-11														x																				High	1	Zone II
OF-12	Bumps River	FC																								x							High	1		
OF-13																																		Low	0	
OF-14																																		Low	0	
OF-15														x																				High	1	Zone II
OF-16																																		Low	0	
OF-17																																		Low	0	
OF-18																																		Low	0	
OF-19	Shubael Pond	Not assessed											x	x								x											High	3	Zone II; swimming/fishing pond; Animal Hospital & Horse Ranch	
OF-20	Round Pond												x	x								x											High	3	Zone II; fishing pond; Men at Work landscaping	
OF-21														x																				High	1	Zone II
OF-22																																				

[illegible]

Barnstable, MA IDDE Outfall Classification and Ranking, By Outfall ID #

Outfall Data			Sampling Data							Problem Outfalls		High Priority Outfalls													Excluded				Ranking		Notes																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																													
Outfall ID	Receiving Water	Receiving Water Impairment ¹	Ammonia ≥ 0.5 mg/L, surfactants ≥ 0.25 mg/L, and bacteria > WQ criteria	Ammonia ≥ 0.5 mg/L, surfactants > 0.25 mg/L, and detectable levels of chlorine	Ammonia > 0.5 mg/L	Surfactants > 0.25 mg/L	Chlorine > 0 mg/L	Bacteria > WQ criteria	Sewer odor detected during inspection	Known or suspected contributions of illicit discharges	Olfactory or visual evidence of sewage	Discharge to/near public beach	Discharge to/near recreational area	Discharge to/near drinking water supply	Discharge to/near shellfish beds	Past Discharge Complaints	Density of Generating Sites ²						Age of development and infrastructure		Catchment areas serviced by septic systems converted to sewer	Historic combined sewer system that has been separated	Density of septic systems ≥30 years old in residential land use	Culverted stream lengths greater than a simple roadway crossing	Discharge to impaired water & potential to carry that pollutant	Presence of older industrial operations	Roadway drainage in undeveloped areas with no dwellings and no sanitary sewers	Outfall is drainage for athletic fields, parks or undeveloped green space & associated parking without services	Cross-country drainage alignments through undeveloped land	Overall Ranking (Problem, High, Low, Excluded)	Ranking Score (Number of Boxes Checked)	Notes																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																								
Car dealers	Car washes	Gas stations	Garden centers	Industrial manufacturing	Other	Industrial areas >40 years old	Sewer areas >40 years old																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																					
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Notes:
1. FC = Fecal Coliform, TN = Total Nitrogen, Hg = Mercury in fish tissue, EB = Estuarine Bioassessments, Plants = Non-native aquatic plants
2. Locations of gas stations, car dealerships, car washes and garden centers obtained from Google in March 2019.

Barnstable, MA Vulnerability Assessment

Outfall ID	Required SVFs								Recommended SVFs				Wet Weather Sampling Required? (Y or N)
	History of SSOs	Common or twin-inert manholes serving storm & sanitary sewer alignments	Common trench construction serving storm & sanitary sewer alignments	Crossings of storm & sanitary sewer alignments where the sanitary system is shallower than the storm drain system	Sanitary sewer alignments known or suspected to have been constructed with an underdrain system	Inadequate sanitary sewer level of service (LOS) resulting in regular surcharging, customer back-ups, or frequent customer complaints	Areas formerly served by combined sewers systems	Sanitary sewer infrastructure defects (e.g., leaking service laterals, cracked, broken, or offset sanitary infrastructure, directly piped connections between storm drain and sanitary sewer infrastructure, or other vulnerability factors identified through I/I, etc.)	Sewer pump/lift stations, siphons, sewer restrictions where power/equipment failures or blockages could result in SSOs	Sanitary sewer & storm drain infrastructure >40 years old	Widespread code-required septic system upgrades required at property transfers due to inadequate soils, water table separation or other physical constraints rather than poor owner maintenance	History of multiple BOH actions addressing widespread septic system failures due to inadequate soils, water table separation, or other physical constraints, rather than poor owner maintenance	
OF-1										x			Optional
OF-2									x	x			Optional
OF-3	x									x			Yes
OF-4										x			Optional
OF-5													No
OF-6										x			Optional
OF-7										x			Optional
OF-8													No
OF-9													No
OF-10													No
OF-11													No
OF-12													No
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OF-25													No
OF-26													No
OF-27										x			Optional
OF-28													No
OF-29													No
OF-30										x			Optional
OF-31													No
OF-32													No
OF-33													No
OF-34													No
OF-35													No

Barnstable, MA Vulnerability Assessment

Outfall ID	Required SVFs								Recommended SVFs				Wet Weather Sampling Required? (Y or N)
	History of SSOs	Common or twin-inert manholes serving storm & sanitary sewer alignments	Common trench construction serving storm & sanitary sewer alignments	Crossings of storm & sanitary sewer alignments where the sanitary system is shallower than the storm drain system	Sanitary sewer alignments known or suspected to have been constructed with an underdrain system	Inadequate sanitary sewer level of service (LOS) resulting in regular surcharging, customer back-ups, or frequent customer complaints	Areas formerly served by combined sewers systems	Sanitary sewer infrastructure defects (e.g., leaking service laterals, cracked, broken, or offset sanitary infrastructure, directly piped connections between storm drain and sanitary sewer infrastructure, or other vulnerability factors identified through I/I, etc.)	Sewer pump/lift stations, siphons, sewer restrictions where power/equipment failures or blockages could result in SSOs	Sanitary sewer & storm drain infrastructure >40 years old	Widespread code-required septic system upgrades required at property transfers due to inadequate soils, water table separation or other physical constraints rather than poor owner maintenance	History of multiple BOH actions addressing widespread septic system failures due to inadequate soils, water table separation, or other physical constraints, rather than poor owner maintenance	
OF-36													No
OF-37													No
OF-38													No
OF-39													No
OF-40													No
OF-41													
OF-42													
OF-43													No
OF-44													No
OF-45													
OF-46													
OF-47													
OF-48													No
OF-49													No
OF-50													No
OF-51													No
OF-52													No
OF-53													No
OF-54													No
OF-55													No
OF-56													No
OF-57										x			Optional
OF-58													No
OF-59													No
OF-60													No
OF-61													No
OF-62													No
OF-63													No
OF-64													No
OF-65													No
OF-66													No
OF-67													No
OF-68													No
OF-69													No
OF-70													No

Barnstable, MA Vulnerability Assessment

Outfall ID	Required SVFs								Recommended SVFs				Wet Weather Sampling Required? (Y or N)
	History of SSOs	Common or twin-inert manholes serving storm & sanitary sewer alignments	Common trench construction serving storm & sanitary sewer alignments	Crossings of storm & sanitary sewer alignments where the sanitary system is shallower than the storm drain system	Sanitary sewer alignments known or suspected to have been constructed with an underdrain system	Inadequate sanitary sewer level of service (LOS) resulting in regular surcharging, customer back-ups, or frequent customer complaints	Areas formerly served by combined sewers systems	Sanitary sewer infrastructure defects (e.g., leaking service laterals, cracked, broken, or offset sanitary infrastructure, directly piped connections between storm drain and sanitary sewer infrastructure, or other vulnerability factors identified through I/I, etc.)	Sewer pump/lift stations, siphons, sewer restrictions where power/equipment failures or blockages could result in SSOs	Sanitary sewer & storm drain infrastructure >40 years old	Widespread code-required septic system upgrades required at property transfers due to inadequate soils, water table separation or other physical constraints rather than poor owner maintenance	History of multiple BOH actions addressing widespread septic system failures due to inadequate soils, water table separation, or other physical constraints, rather than poor owner maintenance	
OF-71													No
OF-72													No
OF-73													No
OF-74													No
OF-75													No
OF-76										x			Optional
OF-77										x			Optional
OF-78										x			Optional
OF-79										x			Optional
OF-80										x			Optional
OF-81										x			Optional
OF-82													No
OF-83													No
OF-84													No
OF-85													
OF-86													
OF-87													
OF-88													No
OF-89													No
OF-90													
OF-91													
OF-92													
OF-93													No
OF-96										x			Optional
OF-97										x			Optional
OF-98													No
OF-99													
OF-100										x			Optional
OF-101													
OF-102													No
OF-103													No
OF-104													No
OF-105													
OF-106													
OF-107													No

Barnstable, MA Vulnerability Assessment

Outfall ID	Required SVFs								Recommended SVFs				Wet Weather Sampling Required? (Y or N)
	History of SSOs	Common or twin-inert manholes serving storm & sanitary sewer alignments	Common trench construction serving storm & sanitary sewer alignments	Crossings of storm & sanitary sewer alignments where the sanitary system is shallower than the storm drain system	Sanitary sewer alignments known or suspected to have been constructed with an underdrain system	Inadequate sanitary sewer level of service (LOS) resulting in regular surcharging, customer back-ups, or frequent customer complaints	Areas formerly served by combined sewers systems	Sanitary sewer infrastructure defects (e.g., leaking service laterals, cracked, broken, or offset sanitary infrastructure, directly piped connections between storm drain and sanitary sewer infrastructure, or other vulnerability factors identified through I/I, etc.)	Sewer pump/lift stations, siphons, sewer restrictions where power/equipment failures or blockages could result in SSOs	Sanitary sewer & storm drain infrastructure >40 years old	Widespread code-required septic system upgrades required at property transfers due to inadequate soils, water table separation or other physical constraints rather than poor owner maintenance	History of multiple BOH actions addressing widespread septic system failures due to inadequate soils, water table separation, or other physical constraints, rather than poor owner maintenance	
OF-108													No
OF-109													No
OF-110													No
OF-111													
OF-113													No
OF-114													No
OF-115										x			Optional
OF-116													No
OF-117													No
OF-118													No
OF-119													No
OF-120													No
OF-121													No
OF-122													No
OF-123										x			Optional
OF-124													No
OF-125													No
OF-126													No
OF-127													No
OF-128													No
OF-129									x	x			Optional
OF-130													No
OF-131										x			Optional
OF-132													No
OF-133													No
OF-134													No
OF-135													No
OF-136													No
OF-137													No
OF-138													No
OF-139													
OF-140													
OF-141													No
OF-142													No
OF-143													No

Barnstable, MA Vulnerability Assessment

Outfall ID	Required SVFs								Recommended SVFs				Wet Weather Sampling Required? (Y or N)
	History of SSOs	Common or twin-inert manholes serving storm & sanitary sewer alignments	Common trench construction serving storm & sanitary sewer alignments	Crossings of storm & sanitary sewer alignments where the sanitary system is shallower than the storm drain system	Sanitary sewer alignments known or suspected to have been constructed with an underdrain system	Inadequate sanitary sewer level of service (LOS) resulting in regular surcharging, customer back-ups, or frequent customer complaints	Areas formerly served by combined sewers systems	Sanitary sewer infrastructure defects (e.g., leaking service laterals, cracked, broken, or offset sanitary infrastructure, directly piped connections between storm drain and sanitary sewer infrastructure, or other vulnerability factors identified through I/I, etc.)	Sewer pump/lift stations, siphons, sewer restrictions where power/equipment failures or blockages could result in SSOs	Sanitary sewer & storm drain infrastructure >40 years old	Widespread code-required septic system upgrades required at property transfers due to inadequate soils, water table separation or other physical constraints rather than poor owner maintenance	History of multiple BOH actions addressing widespread septic system failures due to inadequate soils, water table separation, or other physical constraints, rather than poor owner maintenance	
OF-144													No
OF-145													No
OF-146													No
OF-147										x			Optional
OF-148										x			Optional
OF-149										x			Optional
OF-150										x			Optional
OF-151										x			Optional
OF-152										x			Optional
OF-153													No
OF-154													No
OF-155													No
OF-156													No
OF-157													No
OF-158													No
OF-159													No
OF-160													No
OF-161													No
OF-162													No
OF-163													No
OF-164													No
OF-165													No
OF-166													No
OF-167													No
OF-168													No
OF-169													No
OF-170													No
OF-171													No
OF-172													No
OF-173													No
OF-174													No
OF-175													No
OF-176													No
OF-177													No
OF-178													No

Barnstable, MA Vulnerability Assessment

Outfall ID	Required SVFs								Recommended SVFs				Wet Weather Sampling Required? (Y or N)
	History of SSOs	Common or twin-inert manholes serving storm & sanitary sewer alignments	Common trench construction serving storm & sanitary sewer alignments	Crossings of storm & sanitary sewer alignments where the sanitary system is shallower than the storm drain system	Sanitary sewer alignments known or suspected to have been constructed with an underdrain system	Inadequate sanitary sewer level of service (LOS) resulting in regular surcharging, customer back-ups, or frequent customer complaints	Areas formerly served by combined sewers systems	Sanitary sewer infrastructure defects (e.g., leaking service laterals, cracked, broken, or offset sanitary infrastructure, directly piped connections between storm drain and sanitary sewer infrastructure, or other vulnerability factors identified through I/I, etc.)	Sewer pump/lift stations, siphons, sewer restrictions where power/equipment failures or blockages could result in SSOs	Sanitary sewer & storm drain infrastructure >40 years old	Widespread code-required septic system upgrades required at property transfers due to inadequate soils, water table separation or other physical constraints rather than poor owner maintenance	History of multiple BOH actions addressing widespread septic system failures due to inadequate soils, water table separation, or other physical constraints, rather than poor owner maintenance	
OF-179													No
OF-180													No
OF-181													No
OF-182													No
OF-183													No
OF-184													No
OF-185													No
OF-186													No
OF-187													No
OF-188													No
OF-189													No
INT-1													No
INT-2													No
INT-3													No
INT-4													No
INT-7													No
INT-9													No

Appendix D

SOPs for Dry Weather Outfall Screening

Dry Weather Outfall Inspection/Sampling SOP

Purpose of SOP

1. The inspection of stormwater drainage outfalls and interconnections to assess the **condition of the structure**;
2. The inspection of stormwater drainage outfalls and interconnections to assess the **possibility of illicit discharges**; and
3. The **collection of samples** during dry weather conditions.

Prior to the Leaving the Facility

1. **Check the weather**: Dry weather screening and sampling shall proceed only when no more than 0.1 inches of rainfall has occurred in the previous 24-hour period and no significant snow melt is occurring.
2. **Gather** all required equipment and materials:
 - Necessary Forms:
 - Form 1: Outfall Description and Condition Inventory and Inspection
 - Form 2: Illicit Discharge Detection Inspection
 - Form 3: Dry Weather Water Quality Sampling Form
 - Multi-meters for chlorine, conductivity, salinity, and temperature
 - Sample kits ammonia and surfactants
 - Sampling bottles for *E. coli* analysis
 - Multi meters for dissolved oxygen (*for discharges to impaired and TMDL waters only*)
 - Sampling bottles for total phosphorus, total nitrogen, BOD5, TSS, and fecal coliform analysis (*for discharges to impaired and TMDL waters only*)
 - Dipper with extension rod
 - Tape measure
 - Pen
 - Cooler with ice or ice packs to transport samples
3. **Calibrate** meters following methods in the instruction manuals.

In Field

1. **Observe** each outfall under dry weather conditions. If an outfall/interconnection is inaccessible or submerged, proceed to the first accessible upstream manhole or structure for the observation and sampling.
2. **Record observations** about the condition of the outfall and interconnection on **Form 1: Outfall Description and Condition Inventory and Inspection**. Take photos and document on form.
3. **Record observations** about the possibility of an illicit discharge on **Form 2: Illicit Discharge Detection Inspection**. Take photos and document on form.
4. If flow is present, **collect samples** for analysis following procedures in **Table 1**. Follow hold times and instructions in **Table 2**. Record information in **Form 3**.
5. **Report** any signs of illicit discharges to your supervisor.

Dry Weather Outfall Inspection/Sampling SOP

Form 1: Outfall Description and Condition Inventory and Inspection

Inspection Information					
Outfall ID					
Outfall Location					
Inspector's Name					
Date of Inspection					
Rainfall (in)	Last 24 hours:		Last 48 hours:		
Outfall Description					
Type of Outfall (circle)	Material	Shape	Dimensions	Submerged	
Closed Pipe	<input type="checkbox"/> RCP <input type="checkbox"/> CMP <input type="checkbox"/> HDPE <input type="checkbox"/> Aluminum Other: _____	<input type="checkbox"/> Circular <input type="checkbox"/> Elliptical <input type="checkbox"/> Box Other: _____	Diameter/ Dimensions:	In water: <input type="checkbox"/> No <input type="checkbox"/> Partially <input type="checkbox"/> Fully	With sediment: <input type="checkbox"/> No <input type="checkbox"/> Partially <input type="checkbox"/> Fully
Open Drainage	<input type="checkbox"/> Paved <input type="checkbox"/> Grass <input type="checkbox"/> Rip-rap Other: _____	<input type="checkbox"/> Trapezoid <input type="checkbox"/> Parabolic Other: _____	Depth: _____ Top Width: _____ Bottom Width: _____		
Condition Assessment					
Outfall Damage:	No	Yes	Damage Type: Spalling Cracking/Chipping Corrosion Other:		
Deposits:	No	Yes	None	Grease/Oil	Trash Foam Sediment Other:
Sediment:	No	Yes, Depth:	None	Minor	Moderate High Other:
Vegetation Distress:	No	Yes	Little or No	Moderate	High N/A Other:
Erosion Damage:	No	Yes	Little or No	Moderate	High N/A Other:
Comments or any other non-illicit discharge concerns (e.g. trash or needed infrastructure repairs?):					

Dry Weather Outfall Inspection/Sampling SOP

Form 2: Illicit Discharge Detection Inspection

Outfall ID:		Date:	
Outfall Location:		Inspector's Name:	
Indicators (all outfalls with indicators)			
Indicator	Description (circle all that apply)		
<input type="checkbox"/> Deposits and Stains	Oily Flow Line Paint Other:		
<input type="checkbox"/> Poor Pool Quality (circle)	Odors Colors Oil Sheen Suds Algae Floatables Other:		
<input type="checkbox"/> Pipe Benthic Growth (circle)	Brown Orange Green Other:		
Flow Description			
Flow Present: Yes No		Notes:	
Flow Description: Trickle Moderate Substantial			Flow Depth:
Physical Indicators (flowing outfalls)			
Indicator	Description	Severity Indicators	Notes
Odor	<input type="checkbox"/> Sewage	<input type="checkbox"/> 1 – Faint (unclear source)	<i>Confirm the odor is coming from the discharge location and water and not the surrounding area. Avoid deeply inhaling odors as they may potentially be harmful vapors.</i>
	<input type="checkbox"/> Petroleum/Gas	<input type="checkbox"/> 2 – Easily detected	
	<input type="checkbox"/> Sulfide	<input type="checkbox"/> 3 – Noticeable from a distance	
	<input type="checkbox"/> Rancid/Sour		
	<input type="checkbox"/> Other: _____		
Color	<input type="checkbox"/> Clear <input type="checkbox"/> Brown	<input type="checkbox"/> 1 – Faint colors in sample bottle	<i>Color is defined by the tint or intensity of color observed.</i>
	<input type="checkbox"/> Gray <input type="checkbox"/> Yellow	<input type="checkbox"/> 2 – Clearly visible in sample bottle	
	<input type="checkbox"/> Green <input type="checkbox"/> Orange	<input type="checkbox"/> 3 – Clearly visible in the flow	
	<input type="checkbox"/> Red <input type="checkbox"/> Other: _____		
Turbidity/Cloudiness		<input type="checkbox"/> 1 – Slight <input type="checkbox"/> 2 – Cloudy <input type="checkbox"/> 3 – Opaque	<i>Turbidity or cloudiness is a measure of how easily light can penetrate through the sample.</i>
Floatables (other than trash)	<input type="checkbox"/> Sewage (toilet paper, etc.) <input type="checkbox"/> Suds <input type="checkbox"/> Petroleum/oil sheen <input type="checkbox"/> Other: _____	<input type="checkbox"/> 1 – Few/slight; origin not obvious <input type="checkbox"/> 2 – Some; indications of origin <input type="checkbox"/> 3 – Some; origin clear	<i>- In some cases, surface sheens may be created by in-stream processes. A thick or swirling sheen with a gas-like odor may indicate an oil discharge.</i> <i>- Suds that break up quickly may simply indicate water turbulence. Suds with a strong organic/sewage odor may indicate sewage. Suds with a fragrant odor may indicate laundry water.</i>
Possibility of Illicit Discharge			Sum of Severity Indicators: _____
<input type="checkbox"/> Unlikely	<input type="checkbox"/> Potential (two or more indicators)	<input type="checkbox"/> Suspect (one or more indicators at severity 3)	<input type="checkbox"/> Obvious
Comments/Possible Sources:			

Dry Weather Outfall Inspection/Sampling SOP

Table 1: Sampling Protocol

General Sampling Protocols

- 1) Do not eat, drink or smoke during sample collection and processing.
- 2) Do not collect or process samples near a running vehicle.
- 3) Do not park vehicles in the immediate sample collection area, including both running and non-running vehicles.

Sample Collection Protocols

- 1) Bring all materials and equipment including all forms, the cooler containing the sample bottles, and multi-meters to the site where the sample is going to be taken.
- 2) For any sample to be collected with a **multi-meter**, follow this protocol:
 - a. Turn on multi-meters and place the probe in the flow being careful not to let it rest on the bottom or become encased in sediment.
 - b. Once the numbers on the probe have stopped changing, record data from the multi-meters onto **Form 3: Dry Weather Water Quality Sampling Form**.
- 3) For any sample that must be collected by **bottle**, follow this protocol:
 - a. Put on clean, powder-free nitrile gloves and be careful not to touch anything other than the dippers or the sampling containers.
 - b. The second sampler should be prepared to open bottles and hand them to the first sampler when needed. The bottle caps should be left in the bags and not placed on the ground or other surface.
 - c. Keep hands away from the bottle opening to prevent contamination.
 - d. Collect the sample by placing the bottle in the main stream of flow, being careful not to allow the water to flow over your hands or the outside of the bottle first.
 - e. Do not overfill the bottle (only fill to about ½ inch from the top of the bottle) and do not dump any liquid from them as some of the bottles supplied by the lab have preservatives.
 - f. Once the sample bottle is filled, immediately hand the bottle to the second sampler to place and tighten the cap on the bottle.
 - g. Label sample bottle with location, date, and time.
 - h. Place the bottle in the plastic bag and immediately store it in the cooler before taking the next sample.
 - i. If the flow cannot be reached by the sampler, remove the dipper and extension rod from the sealed bag. Fill and rinse the dipper in the flow three times being careful not to disturb the sediment. Collect the sample in the dipper and carefully pour into the bottle following the protocol listed above.
- 4) Complete **Form 3: Dry Weather Water Quality Sampling Form** if analytical samples were collected, specify parameters, and note the sample time on the form. This creates a reference point for samples.
- 5) Complete the Chain of Custody for any samples delivered to a laboratory for analytical analysis.
- 6) Clean and maintain all equipment according to user manual.

Dry Weather Outfall Inspection/Sampling SOP

Table 2: Analytical Methods, Detection Limits, Hold Times, and Preservatives

Analyte or Parameter	Analytical Method ¹	Detection Limit	Max. Hold Time	Preservative/Cooling
Ammonia	EPA: 350.2 SM: 4500-NH ₃ C	0.05 mg/L	28 days	Cool ≤6°C, H ₂ SO ₄ to pH <2, none if analyzed immediately
BOD ₅	EPA: 405.1 SM: 5210	EPA: 0.1mg/L SM: 0.1 mg/L	24 hours	Cool ≤6°C
Chlorine	SM: 4500-Cl G	0.02 mg/L	15 minutes	None
Conductivity	EPA: 120.1 SM: 2510B	0.2 µs/cm	28 days	Cool ≤6°C
Indicator Bacteria: <i>E.coli</i>	EPA: 1603 SM: 9221B, 9221F, 9223 B Other: Colilert, Colilert-18	EPA: 1 cfu/100mL SM: 2 MPN/100mL Other: 1 MPN/100mL	6 hours	Cool ≤10°C, 0.0008% Na ₂ S ₂ O ₃
Indicator Bacteria: Enterococcus	EPA: 1600 SM: 9230 C Other: Enterolert	EPA: 1 cfu/100mL SM: 1 MPN/100mL Other: 1 MPN/100mL	6 hours	Cool ≤10°C, 0.0008% Na ₂ S ₂ O ₃
Indicator Bacteria: Fecal coliform	SM: 9221E, 9222D	SM: 1.8 org/100mL	6 hours	Cool 4°C, 0.0008% Na ₂ S ₂ O ₃
Salinity	SM: 2520		28 days	Cool ≤6°C
Surfactants	SM: 5540-C	0.01 mg/L	48 hours	Cool ≤6°C
Temperature	SM: 2550B	Not applicable	Immediate	None
Total Nitrogen (TN) (methods are for TN and TKN, NO ₃ /NO ₂ which comprise TN)	TN SM: 4500 NC TKN EPA: 353-3 TKN SM: 4500 NH ₃ -H NO₃/NO₂ EPA: 353.2 NO₃/NO₂ SM: 4500NO ₃ -F	TN: 0.055 mg/L TKN EPA: 0.05 mg/L NO₃/NO₂: 0.005 mg/L	28 days	Cool ≤6°C, H ₂ SO ₄ to pH <2
Total Phosphorus	EPA: Manual-365.3, Automated Ascorbic acid digestion-365.1 Rev. 2, ICP/AES4 200.7 Rev. 4.4 SM: 4500-P E-F	EPA: 0.01 mg/L SM : 0.01 mg/L	28 days	Cool ≤6°C, H ₂ SO ₄ to pH <2
TSS	EPA: 160.2 (residue, non-filterable) SM: 2540D	EPA: 0.5 mg/L SM: 0.5 mg/L	7 days	Cool ≤6°C

Notes:

Select meters/test kits that can read below the detection limit provided in the table.

Follow the instrumentation/test kit instructions for sampling.

¹SM = Standard Methods

Dry Weather Outfall Inspection/Sampling SOP

Form 3: Dry Weather Water Quality Sampling Form

Outfall ID:		Date:	
Outfall Location:		Inspector's Name:	
FOR ALL OUTFALLS			
Sample Parameter	Field Meter/Test Kit Name	Field Screening Result	
Uses a Field Meter			
Temperature			
Salinity			
Specific Conductance			
Chlorine			
Uses a Test Kit			
Surfactant as MBAS			
Ammonia (NH ₃)			
Uses bottles to be sent to lab (see Table 2 for method, transport, and hold times)			
Sample Parameter	Time/Date	Laboratory	Result
<i>E.coli</i>			
FOR DISCHARGES TO IMPAIRED WATERS ONLY			
Sample Parameter	Field Meter/Test Kit Name	Field Screening Result	
Uses a Field Meter			
Dissolved Oxygen <i>(discharges to oxygen impaired waters)</i>			
Uses bottles to be sent to lab (see Table 2 for method, transport, and hold times)			
Sample Parameter	Time/Date	Laboratory	Result
BOD5 <i>(discharges to oxygen impaired waters)</i>			
Fecal coliform <i>(discharges to fecal coliform impaired waters)</i>			
Total Nitrogen <i>(discharges to estuarine bioassessments or nitrogen impaired waters)</i>			
Total Phosphorus <i>(discharges to phosphorus, DO, excess algal growth, chlorophyll-a, and nutrient / eutrophication biological indicators impaired waters)</i>			
TSS <i>(discharges to secchi disk transparency impaired waters)</i>			

Appendix E

SOPs for Illicit Discharge Source Investigation

Illicit Discharge Source Investigation SOP

Purpose of SOP

1. Once a potential illicit discharge has been identified during routine dry weather sampling or inspection, an investigation to **identify the source** of the illicit discharge must be conducted.
2. **Observations of flow** during dry weather conditions will assist with identifying the source of an illicit discharge.

Prior to the Leaving the Facility

1. **Check the weather**: The illicit discharge source investigation shall proceed only when no more than 0.1 inches of rainfall has occurred in the previous 24-hour period and no significant snow melt is occurring.
2. **Gather** all required equipment and materials:
 - ☐ Necessary Forms:
 - Form 1: Illicit Discharge Source Investigation (at outfall)
 - Form 2: Illicit Discharge Source Investigation (for each structure upstream from outfall)
 - ☐ Detailed map of stormwater drainage infrastructure
 - ☐ Pen

Illicit Discharge Source Investigation

1. Once a potential illicit discharge has been identified during routine dry weather sampling or inspection, **observe the outfall** under dry weather conditions.
2. **Record observations** about the possibility of an illicit discharge on **Form 1: Illicit Discharge Source Investigation (at outfall)**. Take photos and document on form.
3. If flow is present, **proceed to the first accessible upstream manhole or structure** to continue the investigation to the source of the flow.
4. At each structure, **record observations about all flow** from inlet pipes on **Form 2: Illicit Discharge Source Investigation** (for each structure upstream from outfall). Take photos and document on form. Note flow on stormwater map.
5. If an illicit discharge is identified and sampling and flow observations do not identify the source, **use alternative investigation techniques** (additional sampling, dye or smoke testing, television inspection, etc.) as needed to identify the source.
6. Once the source is identified, **notify the responsible entity** of the illicit discharge and encourage voluntary removal.
7. **Use existing regulations** to enforce the removal of the illicit discharge. Impose a compliance schedule and fees (if allowed).

Illicit Discharge Source Investigation SOP

Form 1: Illicit Discharge Source Investigation (at outfall)

Outfall ID:	Date:
Inspector's Name:	
Flow Present: Yes No	
Flow Description (circle): Trickle Moderate Substantial	
Notes (color, odor, trash, etc.):	
Possibility of Illicit Discharge? Yes No	Possible Sources:

Form 2: Illicit Discharge Source Investigation

(for each structure upstream from outfall or key junction structure)

Structure ID:		Date:	
Inspector's Name:			
Flow in Inlet Pipes? Yes No		Notes:	
List all inlet pipes with flow (if more space is required, use back of form)			
Pipe ID		Flow Description (circle): Trickle Moderate Substantial	
		Notes (color, odor, trash, etc.):	
		Possibility of Illicit Discharge? Yes No	Possible Sources:
Pipe ID		Flow Description (circle): Trickle Moderate Substantial	
		Notes (color, odor, trash, etc.):	
		Possibility of Illicit Discharge? Yes No	Possible Sources:
Pipe ID		Flow Description (circle): Trickle Moderate Substantial	
		Notes (color, odor, trash, etc.):	
		Possibility of Illicit Discharge? Yes No	Possible Sources:
Pipe ID		Flow Description (circle): Trickle Moderate Substantial	
		Notes (color, odor, trash, etc.):	
		Possibility of Illicit Discharge? Yes No	Possible Sources:

Appendix F

SOP for Dry Weather Key Junction Investigation/Sampling

Dry Weather Key Junction Screening SOP

Purpose of SOP

1. The inspection of key junction structures to assess the **condition of the structure**;
2. The inspection of key junction structures to assess the **possibility of illicit discharges**; and
3. The **collection of samples** during dry weather conditions.

Prior to the Leaving the Facility

1. **Check the weather**: Dry weather screening and sampling shall proceed only when no more than 0.1 inches of rainfall has occurred in the previous 24-hour period and no significant snow melt is occurring.
2. **Gather** all required equipment and materials:
 - ☐ Necessary Forms:
 - Form 1: Key Junction Structure Description and Condition Inventory
 - Form 2: Illicit Discharge Detection Inspection
 - Form 3: Dry Weather Water Quality Sampling Form
 - ☐ Multi-meter for chlorine
 - ☐ Sample kits for ammonia and surfactants
 - ☐ Dipper with extension rod
 - ☐ Tape measure
 - ☐ Pen
 - ☐ Cooler with ice or ice packs to transport samples
3. **Calibrate** meters following methods in the instruction manuals.

In Field

1. **Observe** each key junction structure under dry weather conditions.
2. **Record observations** about the condition of the key junction structure on **Form 1: Key Junction Structure Description and Condition Inventory and Inspection**. Take photos and document on form.
3. **Record observations** about the possibility of an illicit discharge on **Form 2: Illicit Discharge Detection Inspection**. Take photos and document on form.
4. If flow is present, assign an ID to the flowing pipes on the site map. **collect samples** for analysis following procedures in **Table 1**. Follow hold times and instructions in **Table 2**. Record information in **Form 3**.
5. **Report** any signs of illicit discharges to your supervisor.

Table 2: Analytical Methods, Detection Limits, Hold Times, and Preservatives

Analyte or Parameter	Analytical Method ¹	Detection Limit	Max. Hold Time	Preservative/Cooling
Ammonia	EPA: 350.2 SM: 4500-NH3C	0.05 mg/L	28 days	Cool ≤6°C, H ₂ SO ₄ to pH <2
Chlorine	SM: 4500-Cl G	0.02 mg/L	15 minutes	None
Surfactants	SM: 5540-C	0.01 mg/L	48 hours	Cool ≤6°C

Dry Weather Key Junction Screening SOP

Form 1: Key Junction Structure Description and Condition Inventory

Inspection Information					
Junction ID					
Associated Outfall ID					
Inspector's Name					
Date of Inspection					
Rainfall (in)	Last 24 hours:		Last 48 hours:		
Description of Key Junction Structure					
Type of Structure	Manhole	Catch Basin	Other: _____		
Condition of Structure	Good	Fair	Poor	Comments	Construction Material
Cover					
Frame					
Corbel					
Walls					
Floor					
Key Junction Damage (circle)	Spalling Cracking/Chipping Corrosion Other: _____				
Comments or any other non-illicit discharge concerns (e.g., trash or needed infrastructure repairs?):					

Dry Weather Key Junction Screening SOP

Form 2: Illicit Discharge Detection Inspection

Junction ID:		Date:	
Associated Outfall ID:		Inspector's Name:	
Flow Description			
Flow in Inlet Pipes? Yes No		Notes:	
List all inlet pipes with flow (if more space is required, use back of form)			
Pipe ID		Flow Description (circle): Trickle Moderate Substantial	
		Depth in Center of Flow (in.)	Width (in.)
Pipe ID		Flow Description (circle): Trickle Moderate Substantial	
		Depth in Center of Flow (in.)	Width (in.)
Physical Indicators (<i>all key structures</i>)			
Indicator	Description		
<input type="checkbox"/> Deposits and Stains (circle)	Oily	Flow Line	Paint Other:
<input type="checkbox"/> Pipe Benthic Growth (circle)	Brown	Orange	Green Other:
Physical Indicators (<i>flowing structures/pipes only</i>)			
Indicator	Description	Severity	Notes
Odor	<input type="checkbox"/> Sewage <input type="checkbox"/> Petroleum/Gas <input type="checkbox"/> Sulfide <input type="checkbox"/> Rancid/Sour Other: _____	<input type="checkbox"/> 1 – Faint <input type="checkbox"/> 2 – Easily detected <input type="checkbox"/> 3 – Noticeable from a distance	Confirm the odor is coming from the discharge location and water and not the surrounding area. Avoid deeply inhaling odors as they may potentially be harmful vapors.
Color	<input type="checkbox"/> Clear <input type="checkbox"/> Brown <input type="checkbox"/> Gray <input type="checkbox"/> Yellow <input type="checkbox"/> Green <input type="checkbox"/> Orange <input type="checkbox"/> Red <input type="checkbox"/> Other: _____	<input type="checkbox"/> 1 – Faint colors in sample bottle <input type="checkbox"/> 2 – Clearly visible in sample bottle <input type="checkbox"/> 3 – Clearly visible in the flow	Color is defined by the tint or intensity of color observed
Turbidity/Cloudiness		<input type="checkbox"/> 1 – Slight <input type="checkbox"/> 2 – Cloudy <input type="checkbox"/> 3 – Opaque	Turbidity or cloudiness is a measure of how easily light can penetrate through the sample.
Floatables (other than trash)	<input type="checkbox"/> Sewage (toilet paper, etc.) <input type="checkbox"/> Suds <input type="checkbox"/> Petroleum/oil sheen Other: _____	<input type="checkbox"/> 1 – Few/slight; origin not obvious <input type="checkbox"/> 2 – Some; indications of origin <input type="checkbox"/> 3 – Some; origin clear	- In some cases, surface sheens may be created by in-stream processes. A thick or swirling sheen with a gas-like odor may indicate an oil discharge. - Suds that break up quickly may simply indicate water turbulence. Suds with a strong organic/sewage odor may indicate sewage. Suds with a fragrant odor may indicate laundry water.
Possibility of Illicit Discharge		Sum of Severity Indicators: _____	
<input type="checkbox"/> Unlikely	<input type="checkbox"/> Potential (two or more indicators)	<input type="checkbox"/> Suspect (one or more indicators with severity 3)	<input type="checkbox"/> Obvious
Comments/Possible Sources:			

Dry Weather Key Junction Screening SOP

Table 1: Sampling Protocol

General Sampling Protocols

- 1) Do not eat, drink or smoke during sample collection and processing.
- 2) Do not collect or process samples near a running vehicle.
- 3) Do not park vehicles in the immediate sample collection area, including both running and non-running vehicles.

Sample Collection Protocols

- 1) Bring all materials and equipment including all forms, the cooler containing the sample bottles, and multi-meters to the site where the sample is going to be taken.
- 2) For any sample to be collected with a **multi-meter**, follow this protocol:
 - a. Turn on multi-meters and place the probe in the flow being careful not to let it rest on the bottom or become encased in sediment.
 - b. Once the numbers on the probe have stopped changing, record data from the multi-meters onto **Form 3: Dry Weather Water Quality Sampling Form**.
- 3) For any sample that must be collected by **bottle**, follow this protocol:
 - a. Put on clean, powder-free nitrile gloves and be careful not to touch anything other than the dippers or the sampling containers.
 - b. The second sampler should be prepared to open bottles and hand them to the first sampler when needed. The bottle caps should be left in the bags and not placed on the ground or other surface.
 - c. Keep hands away from the bottle opening to prevent contamination.
 - d. Collect the sample by placing the bottle in the main stream of flow, being careful not to allow the water to flow over your hands or the outside of the bottle first.
 - e. Do not overfill the bottle (only fill to about ½ inch from the top of the bottle) and do not dump any liquid from them as some of the bottles supplied by the lab have preservatives.
 - f. Once the sample bottle is filled, immediately hand the bottle to the second sampler to place and tighten the cap on the bottle.
 - g. Label sample bottle with location, date, and time.
 - h. Place the bottle in the plastic bag and immediately store it in the cooler before taking the next sample.
 - i. If the flow cannot be reached by the sampler, remove the dipper and extension rod from the sealed bag. Fill and rinse the dipper in the flow three times being careful not to disturb the sediment. Collect the sample in the dipper and carefully pour into the bottle following the protocol listed above.
- 4) Complete **Form 3: Dry Weather Water Quality Sampling Form** if analytical samples were collected, specify parameters, and note the sample time on the form. This creates a reference point for samples.
- 5) Complete the Chain of Custody for any samples delivered to a laboratory for analytical analysis.
- 6) Clean and maintain all equipment according to the user manual.

Dry Weather Key Junction Screening SOP

Form 3: Dry Weather Water Quality Sampling Form

Junction ID:	Date and Time:			
Associated Outfall ID:		Inspector's Name:		
Sample Parameter	Field Meter/Test Kit Name	Field Screening Result		
		Pipe ID	Pipe ID	Pipe
	Units:			
<i>Uses a Field Meter</i>				
Chlorine				
<i>Uses a Test Kit</i>				
Surfactant as MBAS				
Ammonia (NH ₃)				

Junction ID:	Date and Time:			
Associated Outfall ID:		Inspector's Name:		
Sample Parameter	Field Meter/Test Kit Name	Field Screening Result		
		Pipe ID	Pipe ID	Pipe
	Units:			
<i>Uses a Field Meter</i>				
Chlorine				
<i>Uses a Test Kit</i>				
Surfactant as MBAS				
Ammonia (NH ₃)				

Appendix G

SOP for Wet Weather Outfall Sampling

Wet Weather Outfall Sampling SOP

Purpose of SOP

- A **wet weather investigation** will be conducted for outfalls that have been identified by the Town of Abington as having a higher potential for illicit connections; and
- The investigation will include an **inspection** of stormwater drainage outfalls and the **collection of samples** during wet-weather induced flows to determine the presence of illicit discharges to the MS4.

Prior to the Leaving the Facility

1. **Check the weather:**
 - The storm event should be large enough to produce stormwater discharge.
 - Wet weather screening and sampling shall proceed when more than 0.1 inches of rainfall has occurred in the previous 24-hour period.
 - Sampling is recommended in the spring when groundwater levels are high.
2. **Gather** all required equipment and materials:
 - Necessary Forms:
 - Form 1: Wet Weather Illicit Discharge Detection Inspection
 - Form 2: Wet Weather Water Quality Sampling Form
 - Multi-meters for chlorine, conductivity, salinity, and temperature
 - Sample kits for ammonia and surfactants
 - Sampling bottles for *E. coli* analysis
 - Multi meters for dissolved oxygen (*for discharges to impaired and TMDL waters only*)
 - Sampling bottles for total phosphorus, total nitrogen, BOD5, TSS, and fecal coliform analysis (*for discharges to impaired and TMDL waters only*)
 - Dipper with extension rod
 - Tape measure
 - Pen
 - Cooler with ice or ice packs to transport samples
3. **Calibrate** meters following methods in the instruction manuals.

In Field

1. **Observe** each outfall under wet weather conditions. If an outfall is inaccessible or submerged, proceed to the first accessible upstream manhole or structure.
2. **Record observations** about the general condition of the structure and the possibility of an illicit discharge on **Form 1: Wet Weather Illicit Discharge Detection Inspection**. Take photos and document on form.
3. **Collect samples** for analysis following procedures in **Table 1**. Follow hold times and instructions in **Table 2**. Record information in **Form 2: Wet Weather Water Quality Sampling Form**.
4. **Report** any signs of illicit discharges to your supervisor.

Wet Weather Outfall Sampling SOP

Form 1: Illicit Discharge Detection Inspection

Outfall ID:		Date:	
Outfall Location:		Inspector's Name:	
Indicators (all outfalls with indicators)			
Indicator	Description (circle all that apply)		
<input type="checkbox"/> Deposits and Stains	Oily Flow Line Paint Other:		
<input type="checkbox"/> Poor Pool Quality (circle)	Odors Colors Oil Sheen Suds Algae Floatables Other:		
<input type="checkbox"/> Pipe Benthic Growth (circle)	Brown Orange Green Other:		
Flow Description			
Flow Present: Yes No		Notes:	
Flow Description: Trickle Moderate Substantial			Flow Depth:
Physical Indicators (flowing outfalls)			
Indicator	Description	Severity Indicators	Notes
Odor	<input type="checkbox"/> Sewage	<input type="checkbox"/> 1 – Faint (unclear source) <input type="checkbox"/> 2 – Easily detected <input type="checkbox"/> 3 – Noticeable from a distance	<i>Confirm the odor is coming from the discharge location and water and not the surrounding area. Avoid deeply inhaling odors as they may potentially be harmful vapors.</i>
	<input type="checkbox"/> Petroleum/Gas		
	<input type="checkbox"/> Sulfide		
	<input type="checkbox"/> Rancid/Sour		
	<input type="checkbox"/> Other: _____		
Color	<input type="checkbox"/> Clear <input type="checkbox"/> Brown <input type="checkbox"/> Gray <input type="checkbox"/> Yellow <input type="checkbox"/> Green <input type="checkbox"/> Orange <input type="checkbox"/> Red <input type="checkbox"/> Other: _____	<input type="checkbox"/> 1 – Faint colors in sample bottle <input type="checkbox"/> 2 – Clearly visible in sample bottle <input type="checkbox"/> 3 – Clearly visible in the flow	<i>Color is defined by the tint or intensity of color observed.</i>
Turbidity/Cloudiness		<input type="checkbox"/> 1 – Slight <input type="checkbox"/> 2 – Cloudy <input type="checkbox"/> 3 – Opaque	<i>Turbidity or cloudiness is a measure of how easily light can penetrate through the sample.</i>
Floatables (other than trash)	<input type="checkbox"/> Sewage (toilet paper, etc.) <input type="checkbox"/> Suds <input type="checkbox"/> Petroleum/oil sheen <input type="checkbox"/> Other: _____	<input type="checkbox"/> 1 – Few/slight; origin not obvious <input type="checkbox"/> 2 – Some; indications of origin <input type="checkbox"/> 3 – Some; origin clear	<i>- In some cases, surface sheens may be created by in-stream processes. A thick or swirling sheen with a gas-like odor may indicate an oil discharge.</i> <i>- Suds that break up quickly may simply indicate water turbulence. Suds with a strong organic/sewage odor may indicate sewage. Suds with a fragrant odor may indicate laundry water.</i>
Possibility of Illicit Discharge			Sum of Severity Indicators: _____
<input type="checkbox"/> Unlikely	<input type="checkbox"/> Potential (two or more indicators)	<input type="checkbox"/> Suspect (one or more indicators at severity 3)	<input type="checkbox"/> Obvious
Comments/Possible Sources:			

Wet Weather Outfall Sampling SOP

Table 1: Sampling Protocol

General Sampling Protocols

- 1) Do not eat, drink or smoke during sample collection and processing.
- 2) Do not collect or process samples near a running vehicle.
- 3) Do not park vehicles in the immediate sample collection area, including both running and non-running vehicles.

Sample Collection Protocols

- 1) Bring all materials and equipment including all forms, the cooler containing the sample bottles, and multi-meters to the site where the sample is going to be taken.
- 2) For any sample to be collected with a **multi-meter**, follow this protocol:
 - a. Turn on multi-meters and place the probe in the flow being careful not to let it rest on the bottom or become encased in sediment.
 - b. Once the numbers on the probe have stopped changing, record data from the multi-meters onto **Form 2: Wet Weather Water Quality Sampling Form**.
- 3) For any sample that must be collected by **bottle**, follow this protocol:
 - a. Put on clean, powder-free nitrile gloves and be careful not to touch anything other than the dippers or the sampling containers.
 - b. The second sampler should be prepared to open bottles and hand them to the first sampler when needed. The bottle caps should be left in the bags and not placed on the ground or other surface.
 - c. Keep hands away from the bottle opening to prevent contamination.
 - d. Collect the sample by placing the bottle in the main stream of flow, being careful not to allow the water to flow over your hands or the outside of the bottle first.
 - e. Do not overfill the bottle (only fill to about ½ inch from the top of the bottle) and do not dump any liquid from them as some of the bottles supplied by the lab have preservatives.
 - f. Once the sample bottle is filled, immediately hand the bottle to the second sampler to place and tighten the cap on the bottle.
 - g. Label sample bottle with location, date, and time.
 - h. Place the bottle in the plastic bag and immediately store it in the cooler before taking the next sample.
 - i. If the flow cannot be reached by the sampler, remove the dipper and extension rod from the sealed bag. Fill and rinse the dipper in the flow three times being careful not to disturb the sediment. Collect the sample in the dipper and carefully pour into the bottle following the protocol listed above.
- 4) Complete **Form 2: Wet Weather Water Quality Sampling Form** if analytical samples were collected, specify parameters, and note the sample time on the form. This creates a reference point for samples.
- 5) Complete the Chain of Custody for any samples delivered to a laboratory for analytical analysis.
- 6) Clean and maintain all equipment according to user manual.

Wet Weather Outfall Sampling SOP

Table 2: Analytical Methods, Detection Limits, Hold Times, and Preservatives

Analyte or Parameter	Analytical Method ¹	Detection Limit	Max. Hold Time	Preservative/Cooling
Ammonia	EPA: 350.2 SM: 4500-NH ₃ C	0.05 mg/L	28 days	Cool ≤6°C, H ₂ SO ₄ to pH <2, none if analyzed immediately
BOD ₅	EPA: 405.1 SM: 5210	EPA: 0.1mg/L SM: 0.1 mg/L	24 hours	Cool ≤6°C
Chlorine	SM: 4500-Cl G	0.02 mg/L	15 minutes	None
Conductivity	EPA: 120.1 SM: 2510B	0.2 µs/cm	28 days	Cool ≤6°C
Indicator Bacteria: <i>E.coli</i>	EPA: 1603 SM: 9221B, 9221F, 9223 B Other: Colilert, Colilert-18	EPA: 1 cfu/100mL SM: 2 MPN/100mL Other: 1 MPN/100mL	6 hours	Cool ≤10°C, 0.0008% Na ₂ S ₂ O ₃
Indicator Bacteria: Enterococcus	EPA: 1600 SM: 9230 C Other: Enterolert	EPA: 1 cfu/100mL SM: 1 MPN/100mL Other: 1 MPN/100mL	6 hours	Cool ≤10°C, 0.0008% Na ₂ S ₂ O ₃
Indicator Bacteria: Fecal coliform	SM: 9221E, 9222D	SM: 1.8 org/100mL	6 hours	Cool 4°C, 0.0008% Na ₂ S ₂ O ₃
Salinity	SM: 2520		28 days	Cool ≤6°C
Surfactants	SM: 5540-C	0.01 mg/L	48 hours	Cool ≤6°C
Temperature	SM: 2550B	Not applicable	Immediate	None
Total Nitrogen (TN) (methods are for TN and TKN, NO ₃ /NO ₂ which comprise TN)	TN SM: 4500 NC TKN EPA: 353-3 TKN SM: 4500 NH ₃ -H NO₃/NO₂ EPA: 353.2 NO₃/NO₂ SM: 4500NO ₃ -F	TN: 0.055 mg/L TKN EPA: 0.05 mg/L NO₃/NO₂: 0.005 mg/L	28 days	Cool ≤6°C, H ₂ SO ₄ to pH <2
Total Phosphorus	EPA: Manual-365.3, Automated Ascorbic acid digestion-365.1 Rev. 2, ICP/AES4 200.7 Rev. 4.4 SM: 4500-P E-F	EPA: 0.01 mg/L SM : 0.01 mg/L	28 days	Cool ≤6°C, H ₂ SO ₄ to pH <2
TSS	EPA: 160.2 (residue, non-filterable) SM: 2540D	EPA: 0.5 mg/L SM: 0.5 mg/L	7 days	Cool ≤6°C

Notes:

Select meters/test kits that can read below the detection limit provided in the table.

Follow the instrumentation/test kit instructions for sampling.

¹SM = Standard Methods

Wet Weather Outfall Sampling SOP

Form 2: Wet Weather Water Quality Sampling Form

Outfall ID:		Date:	
Outfall Location:		Inspector's Name:	
FOR ALL OUTFALLS			
Sample Parameter	Field Meter/Test Kit Name	Field Screening Result	
Uses a Field Meter			
Temperature			
Salinity			
Specific Conductance			
Chlorine			
Uses a Test Kit			
Surfactant as MBAS			
Ammonia (NH ₃)			
Uses bottles to be sent to lab (see Table 2 for method, transport, and hold times)			
Sample Parameter	Time/Date	Laboratory	Result
<i>E.coli</i>			
FOR DISCHARGES TO IMPAIRED WATERS ONLY			
Sample Parameter	Field Meter/Test Kit Name	Field Screening Result	
Uses a Field Meter			
Dissolved Oxygen <i>(discharges to oxygen impaired waters)</i>			
Uses bottles to be sent to lab (see Table 2 for method, transport, and hold times)			
Sample Parameter	Time/Date	Laboratory	Result
BOD5 <i>(discharges to oxygen impaired waters)</i>			
Fecal coliform <i>(discharges to fecal coliform impaired waters)</i>			
Total Nitrogen <i>(discharges to estuarine bioassessments or nitrogen impaired waters)</i>			
Total Phosphorus <i>(discharges to phosphorus, DO, excess algal growth, chlorophyll-a, and nutrient / eutrophication biological indicators impaired waters)</i>			
TSS <i>(discharges to secchi disk transparency impaired waters)</i>			

Appendix H

Field Evaluation Records



DRY WEATHER OUTFALL INSPECTION REPORT

1

To: Mr. Nathan Collins, Assistant Town Engineer
From: Nick Cristofori, P.E., Comprehensive Environmental Inc.
Date: April 7, 2020
Town: Barnstable, MA
Subject: Dry Weather Outfall Inspection and Screening

Under the Environmental Protection Agency's (EPA's) 2016 National Pollutant Discharge and Elimination System (NPDES) Municipal Separate Storm Sewer System (MS4) Permit, regulated communities such as Barnstable are required to inspect all known outfalls and interconnections for the presence of dry weather flow (no more than 0.1-inches of rainfall has occurred during the previous 24-hour period and no significant snow melt is occurring) within three years of the permit effective date, or by June 30, 2021. CEI performed field work related to dry weather screening over the course of six field days in January and February, 2020.

The following relevant outfall conditions were observed:

Table 1 – Dry Weather Flow Screening Results

Parameter	Number
Known Outfalls/Interconnections within the Urbanized Area	159
Outfall that were Attempted to Visit	159
Outfall Not Located or Accessed	22
Outfall Located	137
Outfalls Found Not Flowing	130
Outfalls Found with Flow	7
Found with Illicit Discharge Potential	2*
Total Not Yet Attempted to Visit	0

*See additional information provided under Recommendations and Next Steps

The seven flowing outfalls were sampled for the following parameters as required by the permit: ammonia, chlorine, conductivity, salinity, surfactants, pH, temperature, and enterococcus/e.coli depending on the receiving waterbody type. Six of the seven outfalls were also sampled for total nitrogen and fecal coliform as they discharged directly to impaired waterbodies. Results are as follows:



DRY WEATHER OUTFALL INSPECTION REPORT

2

Table 2 – Dry Weather Flow Screening Results

Outfall ID	Ammonia (mg/L)	Chlorine (mg/L)	Surfactants (mg/L)	Conductivity (uS/cm)	Salinity (ppt)	Temperature (C)	pH (mg/L)	Dissolved Oxygen (mg/L)	E.coli (MPN/100 mL)	Enterococcus (MPN/100 mL)	Total Nitrogen (mg/L)	Fecal Coliform (MPN/100 mL)
OF-2	0.5	0	0.5	2285	1.2	5.6	7.82	12.45		50	1.19	10
OF-41	0	0	1.5	5675	3.05	4.9	7.81	11.25		1	3.27	1
OF-110	3.25	0	0.75	2429	1.25	4.7	7.09	10.02		9	3.8	4
OF-123	0	0.2	0	1225	0.61	8.3	8.01	12.25		2	0.84	2
OF-130	0	0.2	2.5	778	0.38	10.3	8.04	9.65		9	2.22	180
OF-134	0	0.4	0.25	1545	0.78	6.8	8.44	14.69		10	3.14	10
OF-143	0.35	0	0.25	348.6	0.17	7.4	8.38	12.33	67			

Note, results shown in bold above meet or exceed permit criteria for likely sewer input or water quality benchmarks.

Per the 2016 MS4 Permit, the following criteria indicate likely sewer input and should be considered highly likely to contain illicit discharges from sanitary sources:

1. Olfactory or visual evidence of sewage;
2. Ammonia ≥ 0.5 mg/L, surfactants ≥ 0.25 mg/L, and bacteria levels greater than the water quality criteria applicable to the receiving water; and/or
3. Ammonia ≥ 0.5 mg/L, surfactants ≥ 0.25 mg/L, and detectable levels of chlorine.

Recommendations and Next Steps

The following items are recommended as follow-up actions:

Illicit Discharge Follow-Up

- Although none of the sampling data collected from flowing outfalls met the Permit criteria as being highly likely to contain illicit discharges from sanitary sources, it is recommended that OF-130 be investigated due in part to the very high levels of flow observed, elevated surfactant levels, and visual presence of soap suds in the flow. A subsurface gravel wetland stormwater Best Management Practice contributes low levels of flow to this outfall, however there is known baseflow coming from further upgradient in the watershed. Contributing areas upgradient of South Street should be investigated.
- Outfall OF-110, 115, 118, and 130 exhibited some potential illicit discharge indicators such as discolored water; however, only OF-110 and 130 had dry weather flow. Although both do not meet the definition of a potential illicit discharge under the Permit, OF-110 should be investigated for potential illicit discharges due in part to the very high levels of ammonia. OF-130 should be investigated as outlined above. Other outfalls had only minor indicators and did not exhibit dry weather flow, and thus are unlikely to have illicit discharges or require follow-up actions.
- Outfalls OF-24, OF-119, OF-132, and OF-151 were observed to have other small pipes connecting from unknown locations. It is presumed that these are sump pumps or otherwise uncontaminated groundwater discharges based on their locations, however



DRY WEATHER OUTFALL INSPECTION REPORT

3

should be monitored during future years for potential illicit discharges.

Maintenance-Related Follow-Up

- A total of 9 outfalls (OF-19, OF-40, OF-52, OF-54, OF-59, OF-84, OF-126, OF-128, and OF-140) are showing evidence of moderate to severe structural deterioration and should be monitored during future years and/or repaired as soon as practical. Priority outfalls are OF-19, OF-54, OF-126, and OF-140.
- A total of 19 outfalls (OF-10, OF-16, OF-17, OF-20, OF-29, OF-38, OF-45, OF-51, OF-52, OF-54, OF-73, OF-74, OF-87, OF-88, OF-92, OF-115, OF-122, OF-124, and OF-138) were observed to be at least half buried in sediment and should be cleaned out to preserve flow capacity. Priority outfalls are OF-20, OF-29, OF-38, OF-45, OF-52, OF-73, OF-74, OF-88, and OF-124.
- A total of 10 outfalls (OF-12, OF-49, OF-56, OF-68, OF-71, OF-90, OF-96, OF-126, OF-146, and OF-148) exhibit evidence of moderate downstream erosion and/or vegetation distress which should be monitored during future years and/or repaired as soon as practical. Priority outfalls are OF-68, OF-90, and OF-126.

Additional Follow-Up

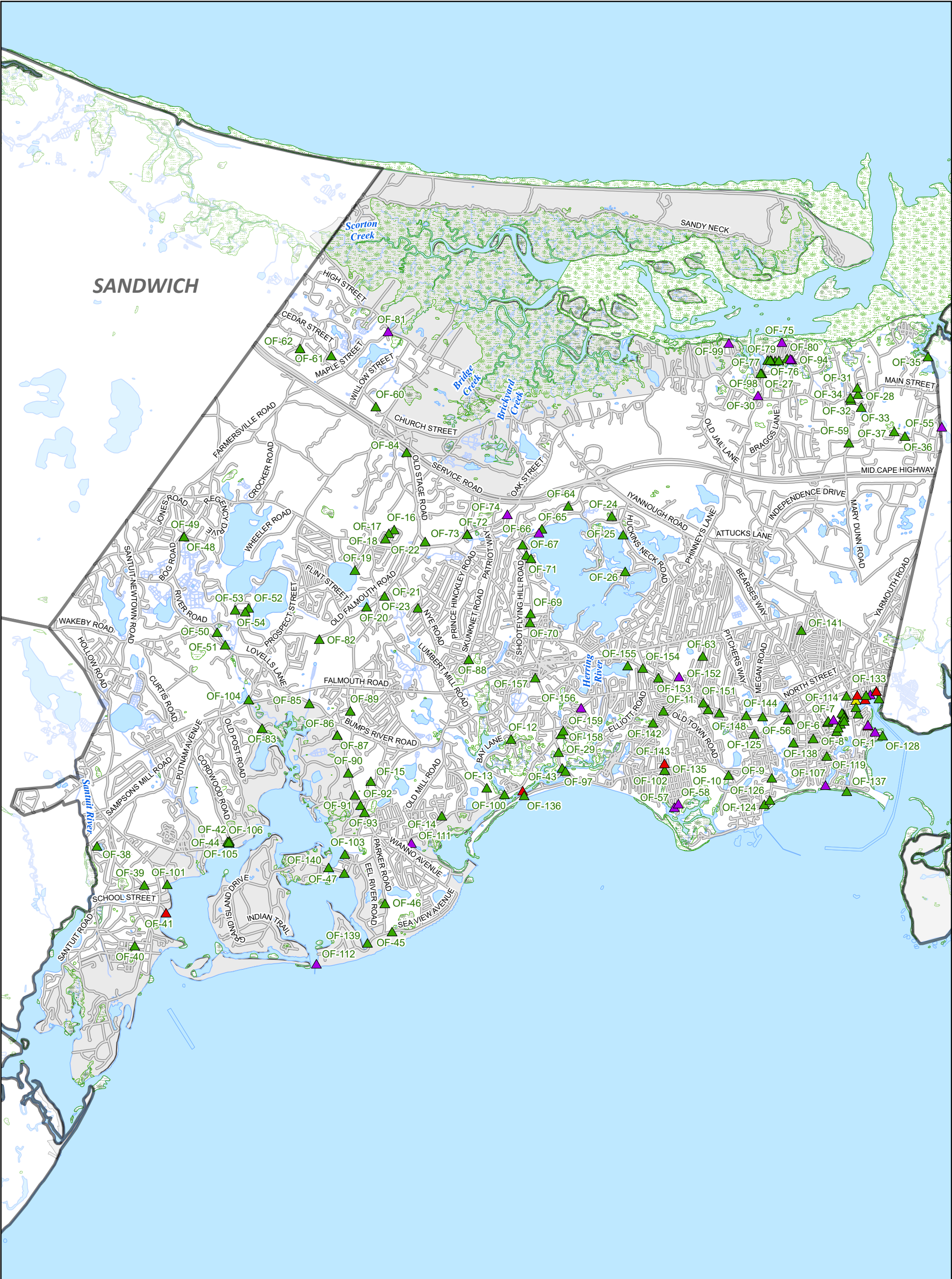
- A total of 22 outfalls could not be evaluated, with 20 unable to be located (OF-1, OF-3, OF-30, OF-55, OF-57, OF-58, OF-66, OF-74, OF-75, OF-81, OF-94, OF-95, OF-99, OF-107, OF-109, OF-111, OF-112, OF-113, OF-152, and OF-156) and 2 unable to be accessed (OF-48 and OF-108). These outfalls should be field-located and evaluated so that dry weather inspections and screening can occur, or determined not to exist and removed from mapping. Outfalls that have not yet been visited or located should be inspected for dry weather flows by the end of Year 3 (June 30, 2022).
- Outfall OF-103 was located, however is believed to be a culvert longer than a simple road crossing and should be revisited during low tide for further evaluation.

If you have any further questions or would like additional information, please feel free to contact me at 800.725.2550 x303 or ncristofori@ceiengineers.com. Thank you.

Nick Cristofori, P.E.
Principal, Project Manager

Attachments:

- Dry Weather Outfall Sampling Results map
- Table of Results
- Stormwater Infrastructure Map

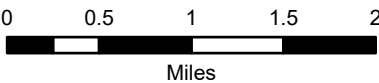


Legend

Outfall Result:

- Flowing
- Not Flowing
- Not Found
- Could Not Access

- Roads
- Lake, Pond, Reservoir
- Wetland, Marsh, Swamp
- Stream, Brook
- Non-Urban Area



Dry Weather Outfall Screening Results
Barnstable, MA



Comprehensive
Environmental
Incorporated

Data Sources: MassGIS, Town of Barnstable, CEI

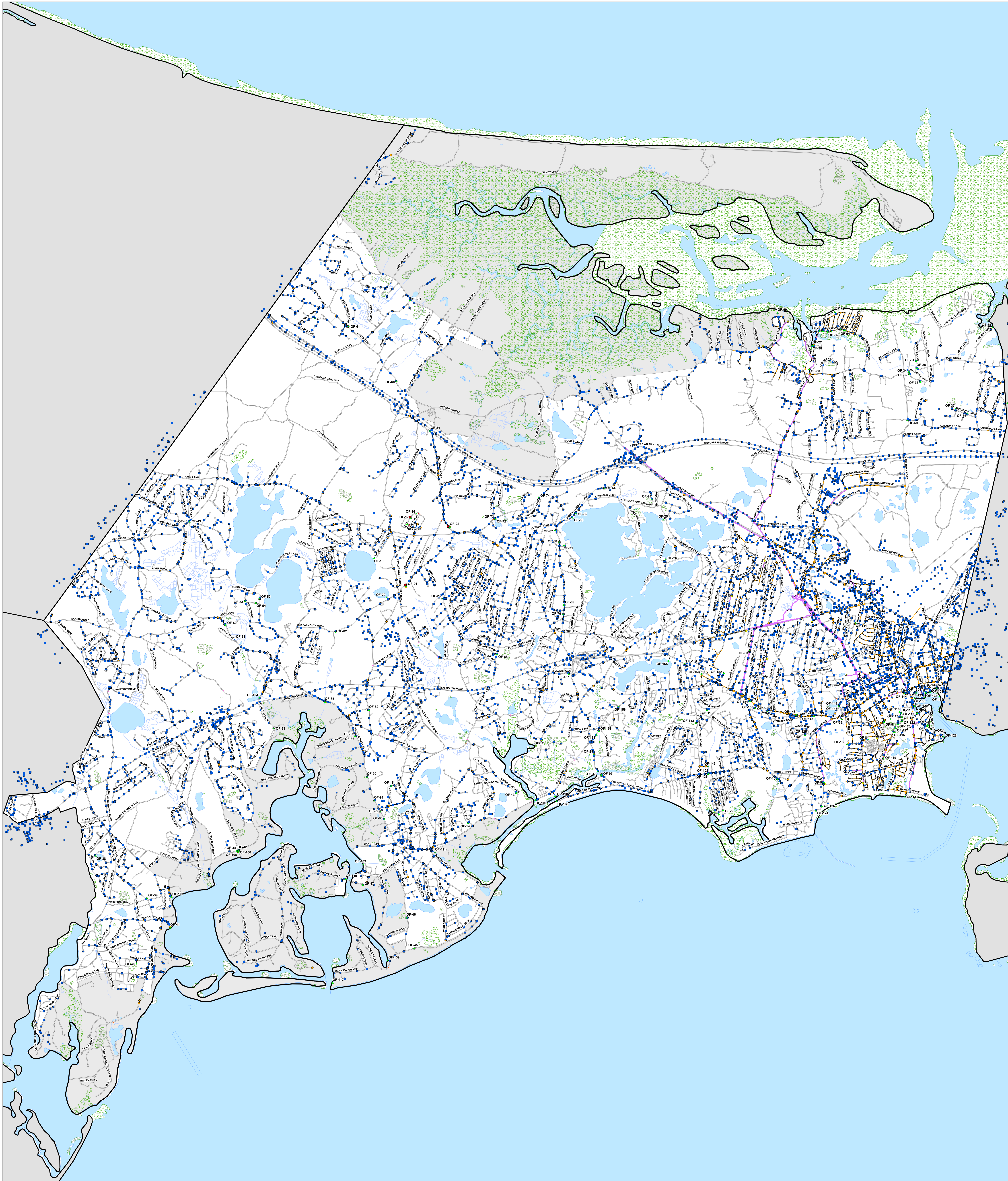
Barnstable Massachusetts Dry Weather Outfall Screening

Outfall Characteristics												Pipe Ends and Headwall Conditions					Erosion, Vegetation, and Sedimentation				Illicit Discharge Potential						
Outfall ID	Lat.	Lon.	Date / Time of Inspection	Outfall Located?	Receiving Waterbody (if any)	Outfall Type	Outfall Shape	Outfall Diameter (inches)	Pipe Material	Outfall Damage	Other Outfall Pipes Comments	Pipe End Treatment	Pipe End Treatment Condition	Headwall Material	Headwall Condition	Pipe and Headwall Condition Comments	Downstream Erosion	Vegetation Distress	Sedimentation Level	Erosion and Vegetation Condition Comments	Any Illicit Discharge Indicators?	Pipe Benthic Growth	Odor	Color	Turbidity / Cloudiness	Floatables	Illicit Discharge Indicator Comments
OF-1	41.64485	-70.2753	1/23/2020 17:43	Not Found																							
OF-2	41.64592	-70.277	1/23/2020 19:50	Found	Hyannis Inner Harbor	Pipe	Round	12	RCP	Spalling		Projecting	Fair	Stone	Good	Some spalling along pipe	No	None	<25%		No						
OF-3	41.64603	-70.2769	1/23/2020 19:41	Not Found																							
OF-4	41.64787	-70.2791	1/30/2020 15:24	Found	Hyannis Inner Harbor	Pipe	Round	12	CMP	Corrosion		Projecting	Fair	N/A, No Headwall	N/A, No Headwall	Invert deterioration	No	None	None		No						
OF-5	41.64655	-70.2859	1/23/2020 16:50	Found		Pipe	Round	36	RCP	None		Flush with Headwall	Good	Concrete	Good	Grate over outfall	No	None	<25%		No						
OF-6	41.64658	-70.2858	1/23/2020 16:49	Found		Pipe	Round	12	RCP	None		Flush with Headwall	Good	Concrete	Good		No	None	None		No						
OF-7	41.64674	-70.2858	1/23/2020 16:53	Found		Pipe	Round	24	RCP	None		Flush with Headwall	Good	Concrete	Good	Missing pieces of rebar from grate over outfall	No	None	None		No						
OF-8	41.64395	-70.2893	1/23/2020 16:25	Found		Pipe	Round	24	CMP	None		Flared End	Good	Stone	Good		No	None	None		No						
OF-9	41.63753	-70.2984	1/30/2020 17:46	Found		Pipe	Rectangular	36 x 24	RCP	None		Flared End	Good	Stone	Good		No	None	None		No						
OF-10	41.63797	-70.308	1/30/2020 18:18	Found		Pipe	Round	12	RCP	None		Flared End	Good	N/A, No Headwall	N/A, No Headwall	Filled with sediment	No	None	50%-75%		No						
OF-11	41.64893	-70.3224	2/20/2020 14:23	Found		Pipe	Round	18	CMP	None		Projecting	Good	N/A, No Headwall	N/A, No Headwall		No	None	<25%		No						
OF-12	41.64445	-70.3563	2/20/2020 15:01	Found		Pipe	Round	24	CMP	None		Projecting	Good	N/A, No Headwall	N/A, No Headwall		Moderate	None	None	Plunge pool, outfall perched	No						
OF-13	41.63644	-70.3618	2/20/2020 15:26	Found		Pipe	Round	10	VC	None		Projecting	Good	N/A, No Headwall	N/A, No Headwall		No	None	None		No						
OF-14	41.6318	-70.3719	2/20/2020 15:34	Found		Pipe	Round	12	HDPE	None		Projecting	Good	Concrete	Good	Pipe and BMP look fairly new and are	No	None	None		No						
OF-15	41.63779	-70.3875	2/20/2020 18:19	Found		Pipe	Round	12	CMP	None		Flush with Headwall	Good	N/A, No Headwall	N/A, No Headwall		No	None	None		No						
OF-16	41.67966	-70.3816	2/21/2020 15:14	Found		Pipe	Round	12	CMP	None		Projecting	Fair	Stone	Good	Submerged and partially buried	No	None	50%-75%		No						
OF-17	41.67909	-70.3828	2/21/2020 15:20	Found		Pipe	Round	10	CMP	Crushed		Projecting	Fair	Stone	Good	End slightly crushed but still functional	No	None	50%-75%		No						
OF-18	41.67815	-70.3836	2/21/2020 15:26	Found		Pipe	Round	12	RCP	None		Flush with Headwall	Good	Concrete	Good		No	None	25%-50%		No						
OF-19	41.673	-70.3905	2/21/2020 15:40	Found	Shubael Pond	Pipe	Round	21	VC	Cracking, Corrosion, Crushed		Flush with Headwall	Poor	Concrete	Poor	End of outfall broken, disconnected from	Moderate	None	25%-50%	Channelization, leaf litter accumulating in channel	No						
OF-20	41.66687	-70.388	2/21/2020 16:07	Found	Round Pond	Pipe	Round	12	CMP	None		Projecting	Fair	N/A, No Headwall	N/A, No Headwall	Outfall buried	No	None	>75%		No						
OF-21	41.66867	-70.384	2/21/2020 15:59	Found		Pipe	Round	18	RCP	Spalling		Flush with Headwall	Good	Concrete	Good	Some minor spalling	No	None	25%-50%		No						
OF-22	41.67762	-70.3748	1/22/2020 20:11	Found		Pipe	Round	24	RCP	None		Flush with Headwall	Good	Concrete	Good	Scouring along edge of pipe but in good condition	Moderate	None	None	Bank erosion	No						
OF-23	41.66656	-70.3766	1/22/2020 20:01	Found		Pipe	Round	12	CMP	None		Projecting	Good	N/A, No Headwall	N/A, No Headwall		No	None	None		No						
OF-24	41.68134	-70.3332	1/22/2020 18:25	Found		Pipe	Round	6	PVC	None	Garden hoses near end of culvert	Flared End	Good	N/A, No Headwall	N/A, No Headwall		No	None	None		No						
OF-25	41.67834	-70.3307	1/22/2020 18:12	Found	Wequaquet Lake	Pipe	Round	12	CMP	None		Projecting	Good	Stone	Good		No	None	None		No						
OF-26	41.67221	-70.3304	1/22/2020 17:58	Found	Wequaquet Lake	Pipe	Round	12	CMP	None		Projecting	Good	N/A, No Headwall	N/A, No Headwall	Submerged and under private dock	No	None	None		No						
OF-27	41.7049	-70.2994	1/22/2020 15:31	Found	Barnstable Harbor	Pipe	Round	24	HDPE	None		Projecting	Good	N/A, No Headwall	N/A, No Headwall	Outfall capped. Projects out of pier	No	None	None		No						
OF-28	41.70125	-70.2781	1/22/2020 14:46	Found	Maraspin creek	Pipe	Round	10	RCP	None		Projecting	Good	N/A, No Headwall	N/A, No Headwall		No	None	<25%		No						
OF-29	41.64214	-70.3458	1/31/2020 18:36	Found	Maraspin creek	Pipe	Round	12	RCP	None		Flush with Headwall	Fair	Concrete	Good	Buried	No	None	>75%		No						
OF-30	41.70121	-70.3003	1/22/2020 15:26	Not Found																							
OF-31	41.70222	-70.2782	1/31/2020 14:12	Found		Pipe	Round	12	CMP	None		Projecting	Good	N/A, No Headwall	N/A, No Headwall		No	None	None		No						
OF-32	41.70024	-70.2797	1/22/2020 14:30	Found		Pipe	Round	12	CMP	None		Projecting	Good	N/A, No Headwall	N/A, No Headwall		No	None	25%-50%		No						
OF-33	41.69899	-70.2775	1/22/2020 14:21	Found		Pipe	Round	12	CMP	None		Projecting	Good	N/A, No Headwall	N/A, No Headwall		No	None	<25%		No						
OF-34	41.70059	-70.2797	1/22/2020 14:37	Found		Pipe	Round	12	CMP	None		Projecting	Good	N/A, No Headwall	N/A, No Headwall		No	None	<25%		No						
OF-35	41.70733	-70.2624	1/22/2020 13:57	Found	Mill Creek	Pipe	Round	12	RCP	None		Projecting	Good	Stone	Good		No	None	None		No						
OF-36	41.69404	-70.2678	1/22/2020 17:03	Found		Pipe	Round	12	CMP	None		Projecting	Good	N/A, No Headwall	N/A, No Headwall		No	None	None		No						
OF-37	41.69491	-70.2701	1/22/2020 17:09	Found		Pipe	Round	12	CMP	None		Projecting	Good	N/A, No Headwall	N/A, No Headwall	Buried under yard waste pile, only partially viewed	Moderate	None	None	Channelization, road sand in channel	No						
OF-38	41.62754	-70.4486	2/21/2020 17:58	Found	No Bottom Pond	Pipe	Round	10	CMP	None		Projecting	Fair	N/A, No Headwall	N/A, No Headwall	Partially buried	No	None	>75%		No						
OF-39	41.62096	-70.4383	2/21/2020 18:12	Found		Pipe	Round	12	HDPE	None		Projecting	Good	N/A, No Headwall	N/A, No Headwall	Buried behind yard waste pile	Moderate	None	None	Plunge pool	No						
OF-40	41.61105	-70.4405	2/21/2020 18:23	Found		Pipe	Round	12	CMP	Cracking, Crushed		Projecting	Fair	N/A, No Headwall	N/A, No Headwall	End of outfall crushed and broken	No	None	None		No						
OF-41	41.61644	-70.4335	2/20/2020 19:40	Found	Cotuit Bay	Pipe	Round	30	HDPE	None		Projecting	Good	N/A, No Headwall	N/A, No Headwall	Barnacles growing on pipe but in good condition	No	None	None		No						
OF-42	41.62813	-70.4191	2/20/2020 19:15	Found		Pipe	Round	12	RCP	None		Flush with Headwall	Good	N/A, No Headwall	N/A, No Headwall	Filled with leaves	Moderate	None	<25%	Plunge pool	No						
OF-43	41.63956	-70.345	1/31/2020 18:43	Found	Centerville River	Pipe	Round	12	RCP	None		Flush with Headwall	Fair	Concrete	Good	Submerged	Moderate	None	<25%	Channelization	No						
OF-44	41.62805	-70.4196	2/20/2020 19:18	Found		Pipe	Round	12	RCP	None		Projecting	Good	N/A, No Headwall	N/A, No Headwall		No	None	None		No						
OF-45	41.61271	-70.3833	2/20/2020 16:01	Found		Pipe	Round	12	CMP	None		Projecting	Good	N/A, No Headwall	N/A, No Headwall	Partially buried	No	None	>75%		No						
OF-46	41.61739	-70.3848	2/20/2020 15:54	Found		Pipe	Round	12	HDPE	None		Projecting	Good	Concrete	Fair	Mortar around pipe cracking	No	None	None		No						
OF-47	41.62253	-70.3937	2/20/2020 16:28	Found	West Bay	Pipe	Round	10	HDPE	None		Projecting	Good	N/A, No Headwall	N/A, No Headwall	Outfall submerged	No	None	<25%		No						
OF-48	41.67888	-70.4285	2/21/2020 17:24	Could Not Access																							
OF-49	41.67888	-70.4285	2/21/2020 17:19	Found		Pipe	Round	12	CMP	None		Projecting	Good	N/A, No Headwall	N/A, No Headwall	Perched	Moderate	None	None	Erosion under outfall, perched	No						
OF-50	41.66295	-70.4213	2/21/2020 17:05	Found		Pipe	Round	12	RCP	None		Flush with Headwall	Good	N/A, No Headwall	N/A, No Headwall	Submerged and partially buried in pit	No	None	25%-50%		No						
OF-51	41.66081	-70.4193	2/21/2020 16:47	Found		Pipe	Round	10	CMP	None		Flush with Headwall	Fair	N/A, No Headwall	N/A, No Headwall	Outfall submerged and partially buried	No	None	50%-75%		No						
OF-52	41.6669	-70.4142	2/21/2020 16:22	Found		Pipe	Round	12	RCP	Cracking		Projecting	Fair	N/A, No Headwall	N/A, No Headwall	Outfall cracked and pieces missing. Pa	No	None	>75%		No						
OF-53	41.66667	-70.4173	2/21/2020 16:30	Found		Pipe	Round	12	RCP	None		Projecting	Good	N/A, No Headwall	N/A, No Headwall		No	None	25%-50%		No						
OF-54	41.66631	-70.415	2/21/2020 16:35	Found		Pipe	Round	10	RCP	Separated		Projecting	Poor	N/A, No Headwall	N/A, No Headwall	Outfall separating at joint, end of pipe	No	None	50%-75%		No						
OF-55	41.69566	-70.2597	1/22/2020 16:56	Not Found																							
OF-56	41.6471	-70.2946	1/30/2020 17:21	Found		Pipe	Round	15	RCP	None		Flush with Headwall	Fair	Concrete	Good	Submerged	Moderate	Moderate	None	Mild scour	No						
OF-57	41.63277	-70.3202	1/30/2020 19:47	Not Found																							
OF-58	41.63341	-70.3192	1/30/2020 19:39	Not Found																							
OF-59	41.69309	-70.2803	1/22/2020 17:22	Found		Pipe	Round	12	CMP	Crushed		Projecting	Fair	Stone	Good	End of pipe crushed and torn	No	None	25%-50%		No						
OF-60	41.70022	-70.3854	2/21/2020 14:49	Found		Pipe	Round	12	CMP	None		Flush with Headwall	Fair	N/A, No Headwall	N/A, No Headwall	Partially buried	Moderate	None	25%-50%	Channelization	No						
OF-61	41.7088	-70.3951	2/21/2020 14:23	Found		Pipe	Round	12	HDPE	None		Projecting	Good	N/A, No Headwall	N/A, No Headwall		No	None	None		No						
OF-62	41.71019	-70.4021	2/21/2020 14:33	Found		Pipe	Round	12	CMP	None		Flush with Headwall	Fair	Stone	Good	Covered with leaves and behind rock	No	None	None		No						
OF-63	41.65795	-70.3134	1/30/2020 15:05	Found		Pipe	Round	12	HDPE	None		Projecting	Good	N/A, No Headwall	N/A, No Headwall		Moderate	None									

Outfall Characteristics												Pipe Ends and Headwall Conditions					Erosion, Vegetation, and Sedimentation				Illicit Discharge Potential						
Outfall ID	Lat.	Lon.	Date / Time of Inspection	Outfall Located?	Receiving Waterbody (if any)	Outfall Type	Outfall Shape	Outfall Diameter (inches)	Pipe Material	Outfall Damage	Other Outfall Pipes Comments	Pipe End Treatment	Pipe End Condition	Headwall Material	Headwall Condition	Pipe and Headwall Condition Comments	Downstream Erosion	Vegetation Distress	Sedimentation Level	Erosion and Vegetation Condition Comments	Any Illicit Discharge Indicators?	Pipe Benthic Growth	Odor	Color	Turbidity / Cloudiness	Floatables	Illicit Discharge Indicator Comments
OF-90	41.63924	-70.3925	2/20/2020 18:27	Found		Pipe	Round	12	CMP	Other	Sidewalk beginning to collapse above	Projecting	Fair	N/A, No Headwall	N/A, No Headwall	Perched	Severe	None	None	Outfall perched, channelization, roadside bank eroding around outfall	No						
OF-91	41.63558	-70.3911	2/20/2020 17:19	Found		Pipe	Round	12	CMP	None		Flush with Headwall	Good	N/A, No Headwall	N/A, No Headwall		Moderate	None	None	Channelization	No						
OF-92	41.6338	-70.39	2/20/2020 17:14	Found		Pipe	Round	12	RCP	None		Flush with Headwall	Fair	N/A, No Headwall	N/A, No Headwall	Partially buried	Moderate	None	50%-75%	Channelization	No						
OF-93	41.63263	-70.389	2/20/2020 17:07	Found		Pipe	Round	10	RCP	Spalling		Projecting	Good	N/A, No Headwall	N/A, No Headwall	Minor spalling in invert but in good condition	Moderate	None	None	Plunge pool and channelization	No						
OF-94	41.70714	-70.2927	1/22/2020 16:36	Not Found																							
OF-95	41.70723	-70.293	1/22/2020 16:33	Not Found																							
OF-96	41.7071	-70.2975	1/22/2020 15:48	Found	Maraspin creek	Pipe	Round	12	RCP	None		Projecting	Good	Concrete	Good	Outfall capped	Moderate	None	None	Plunge pool, outfall perched	No						
OF-97	41.63903	-70.3443	1/31/2020 18:49	Found	Centerville River	Pipe	Round	12	RCP	Spalling		Flush with Headwall	Fair	Concrete	Good	Invert deterioration	No	None	None		No						
OF-98	41.7049	-70.2996	1/22/2020 15:37	Found	Barnstable Harbor	Pipe	Round	24	HDPE	None		Projecting	Good	N/A, No Headwall	N/A, No Headwall	Outfall capped. Projects out of pier	No	None	None		No						
OF-99	41.71001	-70.3067	1/22/2020 15:11	Not Found																							
OF-100	41.63538	-70.3577	2/20/2020 15:12	Found	Centerville River	Pipe	Round	12	RCP	Spalling		Projecting	Fair	N/A, No Headwall	N/A, No Headwall	Minor spalling in invert and chipping	Moderate	None	None	Spalling and erosion along concrete conveyance	No						
OF-101	41.62107	-70.4331	2/20/2020 19:31	Found		Pipe	Rectangular	24 x 4	RCP	None		Flush with Headwall	Good	Concrete	Good		No	None	None		No						
OF-102	41.63899	-70.3222	2/20/2020 14:48	Found		Pipe	Round	12	RCP	None		Flush with Headwall	Good	Concrete	Good		No	None	<25%		No						
OF-103	41.62564	-70.3936	2/20/2020 16:55	Found		Pipe	Round	12	RCP	None		Projecting	Fair	N/A, No Headwall	N/A, No Headwall	Outfall submerged	No	None	<25%		No						
OF-104	41.65161	-70.4145	2/20/2020 18:09	Found	Mill Pond	Pipe	Round	12	CMP	None		Projecting	Good	Concrete	Good		No	None	None		No						
OF-105	41.62775	-70.4192	2/20/2020 19:11	Found		Pipe	Round	12	RCP	None		Projecting	Good	N/A, No Headwall	N/A, No Headwall		No	None	None		No						
OF-106	41.62792	-70.4193	2/20/2020 19:13	Found		Pipe	Round	12	HDPE	None		Projecting	Good	N/A, No Headwall	N/A, No Headwall	Grate over end	No	None	None		No						
OF-107	41.63611	-70.2865	1/23/2020 15:58	Not Found																							
OF-108	41.64935	-70.2799	1/30/2020 15:46	Could Not Access																							
OF-109	41.65115	-70.2763	1/31/2020 15:35	Not Found																							
OF-110	41.63594	-70.3538	1/31/2020 19:11	Found	Centerville River	Pipe	Round	18	CMP	Corrosion		Projecting	Good	Stone	Good	Pipe end/bracer broken off and is in the water	No	None	None		Yes	Orange	None	Brown	None	None	
OF-111	41.62742	-70.3786	2/20/2020 15:43	Not Found																							
OF-112	41.60783	-70.3992	2/21/2020 19:00	Not Found																							
OF-113	41.6472	-70.2845	1/23/2020 17:09	Not Found																							
OF-114	41.65096	-70.2816	1/23/2020 14:28	Found		Pipe	Round	18	RCP	None		Flush with Headwall	Good	Concrete	Good		No	None	<25%		No						
OF-115	41.64506	-70.2839	1/23/2020 15:35	Found		Pipe	Round	12	RCP	Corrosion		Flush with Headwall	Fair	Concrete	Good		No	None	50%-75%		Yes		None	None	None	Oily sheen to water	Oily sheen, decaying wetland smell
OF-116	41.64791	-70.2823	1/23/2020 14:56	Found		Pipe	Round	12	CMP	Crushed		Projecting	Fair	Concrete	Fair	Submerged and dented but still functional. Erosion above outfall	No	None	None		No						
OF-117	41.64787	-70.2823	1/23/2020 14:59	Found		Pipe	Round	24	RCP	None		Flush with Headwall	Good	Concrete	Good		No	None	25%-50%		No						
OF-118	41.64809	-70.2827	1/23/2020 14:43	Found		Pipe	Round	12	PVC	None		Flared End	Good	Stone	Good		No	None	<25%		Yes	Green	None	None	None	None	Green growth in BMP
OF-119	41.6409	-70.2862	1/23/2020 15:47	Found		Pipe	Round	24	RCP	Spalling	Black hose in pool beneath outfall	Flush with Headwall	Good	Concrete	Good	Minimal scouring along invert	Moderate	None	None	Plunge pool	No						
OF-120	41.64628	-70.2831	1/23/2020 15:18	Found		Pipe	Round	36	RCP	None		Flush with Headwall	Good	Concrete	Good		No	None	<25%		No						
OF-121	41.64739	-70.2822	1/23/2020 15:05	Found		Pipe	Round	12	CMP	None		Projecting	Good	Concrete	Good	Submerged	No	None	<25%		No						
OF-122	41.64679	-70.2822	1/23/2020 15:13	Found		Pipe	Round	10	RCP	None		Flush with Headwall	Good	Concrete	Good		No	None	50%-75%		No						
OF-123	41.6503	-70.2773	1/31/2020 15:43	Found	Hyannis Inner Harbor	Pipe	Round	24	RCP	Corrosion		Projecting	Fair	Stone	Good	Corrosion with heavy algae and barnacles	No	little	None		No						
OF-124	41.63305	-70.3002	1/30/2020 18:08	Found		Pipe	Round	12	CMP	None		Flush with Headwall	Good	N/A, No Headwall	N/A, No Headwall	Outfall almost buried	No	None	>75%		No						
OF-125	41.64475	-70.3022	1/30/2020 17:34	Found		Pipe	Round	12	CMP	Dented		Projecting	Fair	N/A, No Headwall	N/A, No Headwall	Outfall dented but functional	No	None	None		No						
OF-126	41.63375	-70.2989	1/30/2020 17:58	Found		Pipe	Round	12	RCP	Collapsing		Projecting	Poor	N/A, No Headwall	N/A, No Headwall	Pipe collapsing and separating at joint	Severe	None	None	Bank eroding away around outfall causing collapsing	No						
OF-127	41.64562	-70.2835	1/23/2020 15:23	Found		Pipe	Round	36	RCP	None		Flush with Headwall	Good	Concrete	Good		Moderate	None	<25%		No						
OF-128	41.6442	-70.2737	1/23/2020 17:49	Found	Hyannis Inner Harbor	Pipe	Round	6	CI	Corrosion		Projecting	Fair	Stone	Good	Corroding, end of pipe snapped off	No	None	None	Bank erosion	No						
OF-129	41.64893	-70.2795	1/30/2020 15:36	Found	Hyannis Inner Harbor	Pipe	Round	12	HDPE	None		Projecting	Good	N/A, No Headwall	N/A, No Headwall		No	None	None		No						
OF-130	41.65097	-70.2793	1/30/2020 15:52	Found	Hyannis Inner Harbor	Pipe	Round	24	RCP	None		Projecting	Good				No	None	None		Yes		None	None	None	Soap suds	Flow is sudsy with a sheen
OF-131	41.65095	-70.2772	1/31/2020 16:30	Found	Hyannis Inner Harbor	Pipe	Round	24	RCP	None		Flush with Headwall	Good	Concrete	Good	Outfall capped	No	None	None		No						
OF-132	41.65038	-70.2744	1/23/2020 14:04	Found	Hyannis Inner Harbor	Pipe	Round	12	CMP	None	PVC pipes under dock, steady flow with surges of heavy flow	Projecting	Good	Stone	Good		No	None	None		No						
OF-133	41.65174	-70.2749	1/23/2020 13:55	Found	Hyannis Inner Harbor	Pipe	Round	12	HDPE	None		Projecting	Good	N/A, No Headwall	N/A, No Headwall		No	None	None		No						
OF-134	41.65179	-70.275	1/23/2020 13:51	Found	Hyannis Inner Harbor	Pipe	Round	24	RCP	None		Projecting	Good	N/A, No Headwall	N/A, No Headwall		No	None	None		No						
OF-135	41.63897	-70.3222	2/20/2020 14:42	Found		Pipe	Round	18	RCP	None		Flush with Headwall	Good	Concrete	Good		No	None	<25%		No						
OF-136	41.63503	-70.3535	1/31/2020 18:58	Found	Centerville River	Pipe	Round	12	CMP	None		Flared End	Good	N/A, No Headwall	N/A, No Headwall		No	None	<25%		No						
OF-137	41.63503	-70.2818	1/31/2020 15:21	Found	Hyannis Harbor	Pipe	Round	36	RCP	None		Projecting	Good	Stone	Good		No	None	None		No						
OF-138	41.64325	-70.2936	1/23/2020 16:39	Found		Pipe	Round	24	RCP	None		Projecting	Good	N/A, No Headwall	N/A, No Headwall		No	None	50%-75%		No						
OF-139	41.61079	-70.3888	2/20/2020 16:11	Found	Eel River	Pipe	Round	10	CMP	Spalling		Projecting	Good	N/A, No Headwall	N/A, No Headwall	Slight spalling, outfall submerged	No	None	<25%		No						
OF-140	41.62348	-70.3972	2/20/2020 16:36	Found	North Bay	Pipe	Round	12	CMP	Corrosion		Flush with Headwall	Poor	Stone	Good	Severally deteriorated, appears to have failed	No	None	<25%		No						
OF-141	41.66201	-70.2914	1/30/2020 14:48	Found		Pipe	Round	21	CMP	None		Projecting	Good	N/A, No Headwall	N/A, No Headwall	Good	No	None	<25%		No						
OF-142	41.6468	-70.3247	2/20/2020 14:34	Found		Pipe	Round	18	CMP	None		Flush with Headwall	Good	N/A, No Headwall	N/A, No Headwall		Moderate	None	None	Channelization	No						
OF-143	41.64016	-70.3223	1/30/2020 20:10	Found	Unnamed Brook	Pipe	Round	18	RCP	Cracking		Projecting	Fair	N/A, No Headwall	N/A, No Headwall	Large piece of pipe cracked off of end	No	None	None		No						
OF-144	41.64917	-70.2952	1/30/2020 17:06	Found	Aunt Betty's Pond	Pipe	Round	30	RCP	Spalling		Flush with Headwall	Fair	Concrete	Good	Some spalling on invert	No	None	None		No						
OF-145	41.64912	-70.2952	1/30/2020 17:03	Found	Aunt Betty's Pond	Pipe	Round	12	RCP	Spalling		Flush with Headwall	Fair	Concrete	Good	Some spalling on invert	No	None	None		No						
OF-146	41.64709	-70.2946	1/30/2020 17:16	Found		Pipe	Round	30	RCP	Other	Rebar gate bent and broken	Flush with Headwall	Fair	Concrete	Good		Moderate	Moderate	<25%	Mild scour	No						
OF-147	41.64766	-70.3003	1/30/2020 19:21	Found		Pipe	Round	12	RCP	None		Flush with Headwall	Good	Concrete	Good		No	None	None		No						
OF-148	41.64828	-70.3032	1/30/2020 19:12	Found	Fawcettes Pond	Pipe	Round	12	RCP	None		Flush with Headwall	Good	Concrete	Good		Moderate	Moderate	None	Channel scour	No						
OF-149	41.64837	-70.3099	1/30/2020 19:02	Found		Pipe	Round	18	RCP	None		Flush with Headwall	Good	Concrete	Good		No	None	<25%		No						
OF-150	41.64898	-70.3124	1/30/2020 18:53	Found		Pipe	Round	18	RCP	None		Flared End	Good	N/A, No Headwall	N/A, No Headwall		Moderate	None	<25%	Eroding a pool	No						

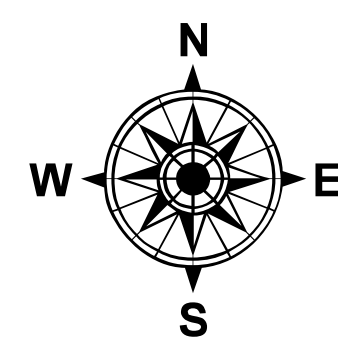
Flow Characteristics				Sampling Parameters																	Overall Comments
Outfall ID	Is Dry Weather Flow Present?	Flow Description	Flow Depth (inches)	Revisit Required?	Is a Sample Required?	Unique ID	Pollutant(s) of Concern	Ammonia Result (mg/L)	Chlorine Result (mg/L)	Surfactants Result (mg/L)	Conductivity Result (uS/cm)	Salinity Result (ppt)	Temperature Result (C)	pH	Dissolved Oxygen (mg/L)	E. Coli Result (CFU/100 mL)	Enterococcus Result (MPN/100 mL)	Total Nitrogen Result (mg/L)	Fecal Coliform	Overall Comments	
OF-1																					Pipe may be buried. No flow in catch basin but yard drain above marked location is overflowing with water
OF-2	Yes	Moderate	4	No	Yes	OF-2	Fecal coliform, total nitrogen	0.5	0	0.5	2285	1.2	5.6	7.82	12.45		50	1.04	10	Fecal Coliform result is <10	
OF-3																					Pipe buried or collapsed. Water with orange discoloration bubbling up through sand in marked location. No flow in catch basin
OF-4	No			No	No																
OF-5	No			No	No																Sediment build up behind grate
OF-6	No			No	No																
OF-7	No			No	No																Rebar missing from grate
OF-8	No			No	No																Puddle in flared end of outfall, no flowing water. Discharges to apparent BMP or pool of water
OF-9	No			No	No																Culvert with drainage connection. No flow in catch basin
OF-10	No			No	No																Culvert with drainage connection, no flow in catch basin. Filled with sediment 75%
OF-11	No			No	No																Standing water, no flow in catch basins
OF-12	No			No	No																
OF-13	No			No	No																
OF-14	No			No	No																Outfall discharges to BMP
OF-15	No			No	No																
OF-16	No			No	No																Culvert with drainage connection. Pipe partially buried. No flow in catch basin. Some bricks supporting catch basin missing creating a gap
OF-17	No			No	No																Culvert with drain connection, no flow in catch basin. Outfall almost filled, road gravel deposits in channel
OF-18	No			No	No																
OF-19	No			No	No																Pipe separated from headwall, pipe end broken and pieces missing. Eroding small channel into lake bed. Recommend immediate attention.
OF-20	No			No	No																Outfall buried
OF-21	No			No	No																Shares headwall with culvert, no flow from outfall
OF-22	No			No	No																Receives flow from BMP across the street as well as catch basin. No flow in catch basin, standing water in pipe
OF-23	No			No	No																Rip rap conveyance
OF-24	No			No	No																Outfall not found in location, possibly buried or removed. Paved open drainage outfall found 15 ft from marked location. PVC pipe buried in leaves at end of c
OF-25	No			No	No																
OF-26	No			No	No																Outfall under private dock and boat
OF-27	No			No	No																Outfall capped, no flow in catch basin
OF-28	No			No	No																Discharges next to culvert for Maraspin Creek. Water from creek, no flow confirmed in catch basin
OF-29	No			No	No																Outfall almost entirely buried
OF-30																					Could not locate outfall potentially buried under brush pile
OF-31	No			No	No																
OF-32	No			No	No																Sediment deposit 4 ft from outlet surcharging pipe. Standing water, no flow confirmed in catch basin
OF-33	No			No	No																Standing water with no flow, confirmed in upstream catch basin. Culvert for small intermittent stream with drainage connection.
OF-34	No			No	No																
OF-35	No			No	No																No flow upon arrival, water flowing into outfall from rising tide at end of inspection
OF-36	No			No	No																Yard waste pile in front of outfall
OF-37	No			No	No																Partially buried under residential yard waste pile. Channelization downstream of outfall
OF-38	No			No	No																Outfall partially buried in sediment and leaf litter. Discharges to pit may surcharge during flow
OF-39	No			No	No																Outfall becoming buried by residential yard waste pile
OF-40	No			No	No																Outfall end is crushed and broken
OF-41	Yes	Moderate	0.25	No	Yes	OF-41	Fecal coliform, total nitrogen	0	0	1.5	5675	3.05	4.9	7.81	11.25		1	0.3	1	Enterococcus and Fecal Coliform results were both less than 1	
OF-42	No			No	No																Outfall buried in leaf litter
OF-43	No			No	No																Channelization and a plunge pool with sediment deposits causing surcharging. No flow in catch basin
OF-44	No			No	No																
OF-45	No			No	No																Partially buried and filled with sediment
OF-46	No			No	No																
OF-47	No			No	No																Outfall submerged, probed pool to verify outfall. No flow in catch basin but catch basin filled with water.
OF-48				Yes																	Outfall discharges to fenced in BMP, could not locate from outside fence
OF-49	No			No	No																Discharges to BMP
OF-50	No			No	No																Partially buried, probed to verify pipe. Discharges to a pit with no conveyance. Submerged but no flow in catch basin
OF-51	No			No	No																Partially buried, probed to verify pipe. Discharges to a pit with no conveyance. Submerged but no flow in catch basin
OF-52	No			No	No																Outfall cracked, partially buried
OF-53	No			No	No																
OF-54	No			No	No																Pipe end covered in sediment and leaf litter. Beginning to separate at joint
OF-55																					Could not locate potentially submerged. No flow in catch basin
OF-56	No			No	No																Shares headwall with OF-146
OF-57																					Flagged pole and hole in location but pipe not found. Potentially buried
OF-58																					Potentially buried in yard waste
OF-59	No			No	No																Outfall crushed on end
OF-60	No			No	No																Partially buried in leaves, some minor channelization down stream
OF-61	No			No	No																
OF-62	No			No	No																Appears homeowner placed rock wall in front of outfall, covered in leaves but in good condition
OF-63	No			No	No																Discharges to BMP/basin
OF-64	No			No	No																
OF-65	No			No	No																Sediment build up in front of outfall may cause surcharging during flow event. Erosion on bank below outfall
OF-66																					Followed catch basin orientation and GPS down slope to water's edge, no pipe found
OF-67	No			No	No																
OF-68	No			No	No																Outfall perched, severe erosion about 5' deep
OF-69	No			No	No																Discharges to small swale, filled with standing water. No flow in upstream catch basin
OF-70	No			No	No																Gravel pad at end of outlet redirecting flow path to the right
OF-71	No			No	No																Channel erosion, concrete blocks in channel to slow flow
OF-72	No			No	No																Puddle in invert but no flow. Discharges next to culvert
OF-73	No			No	No																Filled its sediment
OF-74																					Signs of headwall but unable to find pipe. Likely buried
OF-75				No																	Outfall not found, pool and flagged stake in GPS location. Pipe potentially buried and submerged. No flow in catch basin
OF-76	No			No	No																Outfall capped, plunge pool present
OF-77	No			No	No																Outfall capped, no flow in catch basin. Pipe buried only cap is visible.
OF-78	No			No	No																Outfall capped, no flow in catch basin
OF-79	No			No	No																Outfall capped, plunge pool present
OF-80	No			No	No																Plunge pool or basin present. Outfall capped and submerged, no flow in catch basin. Erosion present behind outfall
OF-81																					Pipe and associated catch basin not found. Road looks recently repaved
OF-82	No			No	No																
OF-83	No			No	No																Partially buried, probed to verify pipe. Discharges to a pit with no conveyance. Submerged but no flow in catch basin
OF-84	No			No	No																Moderate vegetation distress, fallen tree next to outfall and dead trees close to outfall but may be due to highway proximity
OF-85	No			No	No																Shares headwall with culvert, no flow from outfall
OF-86	No			No	No																Slight spalling, minimal sedimentation
OF-87	No			No	No																At least 3/4 full with sediment, slight spalling
OF-88	No			No	No																Outfall filled with sediment. Erosion above outfall
OF-89	No			No	No																Outfall beginning to perch but in good condition

Outfall ID	Flow Characteristics				Sampling Parameters															Overall Comments
	Is Dry Weather Flow Present?	Flow Description	Flow Depth (inches)	Revisit Required?	Is a Sample Required?	Unique ID	Pollutant(s) of Concern	Ammonia Result (mg/L)	Chlorine Result (mg/L)	Surfactants Result (mg/L)	Conductivity Result (uS/cm)	Salinity Result (ppt)	Temperature Result (C)	pH	Dissolved Oxygen (mg/L)	E. Coli Result (CFU/100 mL)	Enterococcus Result (MPN/100 mL)	Total Nitrogen Result (mg/L)	Fecal Coliform	
OF-90	No			No	No															Severe erosion around and above outfall. Sidewalk beginning to collapse
OF-91	No			No	No															
OF-92	No			No	No															Partially buried in bank, channelization downstream
OF-93	No			No	No															
OF-94																				Outfall not found, overgrown phragmites. Not found in previous inspections
OF-95																				Outfall not found, overgrown phragmites. Not found in previous inspections
OF-96	No			No	No															Outfall capped. Standing water no flow in catch basin
OF-97	No			No	No															
OF-98	No			No	No															Outfall capped, no flow in catch basin
OF-99																				Could not locate pipe. Flagged mushroom anchor in GPS location. Outfall not found in previous inspection. Hole directly upstream with pool of water, pipe may be under bridge
OF-100	No			No	No															
OF-101	No			No	No															Outfall is an overflow for the large catch basin draining parking lot. Stake found a couple feet from the overflow, potentially a buried outfall pipe
OF-102	No			No	No															Partially submerged from stream, but no flow in catch basins. Shares headwall with OF-135
OF-103	No			Yes	No															Believed to be a culvert longer than a roadway crossing for wetlands on Wianno Golf Course. Will return during low tide to assess flow
OF-104	No			No	No															
OF-105	No			No	No															Receives flow from BMP with OF-105. Discharges to second BMP
OF-106	No			No	No															Discharges to BMP
OF-107																				Pipe not located, overgrown vegetation possibly hidden or buried. Not found in previous inspection
OF-108				Yes																Outfall blocked by moored boat on pier
OF-109																				Catch basins are dry and filled with sediment. No outfall found, could see sand bottom under water and still no outfall was present
OF-110	Yes	Moderate	1	No	Yes	OF-110	Fecal coliform, total nitrogen	3.25	0	0.75	2429	1.25	4.7	7.09	10.02		9	3.8	4	Orange growth and brown discolored water flowing from pipe
OF-111																				Pipe not found. Unmapped infiltration galley with no outlet upstream of location, outfall potentially removed or submerged in wetland.
OF-112																				Could not find outfall pipe, possibly buried by sand. Not found in previous inspections
OF-113																				Could not locate in overgrown vegetation. Not found during previous inspection either
OF-114	No			No	No															Pit around outfall surcharging pipe and causing ponding. Standing water no flow confirmed in upstream catch basin
OF-115	No			No	No															Culvert draining wetlands across the street. No flow in catch basins
OF-116	No			No	No															Submerged in stream, no flow in catch basin
OF-117	No			No	No															Culvert for small stream with drainage connection. No flow in catch basins
OF-118	No			No	No															Green growth in BMP basin. Growth contained to basin, not in stream
OF-119	No			No	No															Rubber hose present. Small plunge pool below outfall. Black rubber hose in pool
OF-120	No			No	No															Culvert with drainage connection. No flow in catch basins. Water murkier than upstream segment
OF-121	No			No	No															Submerged, no flow in upstream catch basin
OF-122	No			No	No															Flow supposed to be directed to small 1' swale and directed out but sediment build up disrupting flow
OF-123	Yes	Trickle	0.5	No	Yes	OF-123	Fecal coliform, total nitrogen	0	0.2	0	1225	0.61	8.3	8.01	12.25		2	0.84	2	Submerged but flow in upstream unmapped manhole in park. Samples collected from manhole. Fecal Coliform result is <2
OF-124	No			No	No															Outfall almost buried, with a pit in front of the outfall
OF-125	No			No	No															
OF-126	No			No	No															Bank erosion furthering pipe collapse and separation. 2 sections of separated pipe
OF-127	No			No	No															Culvert draining wetlands across the street. No flow in catch basins
OF-128	No			No	No															End of pipe broken and corroding but still functional
OF-129	No			No	No															Outfall submerged during low tide, no flow in catch basins
OF-130	Yes	Substantial	1	No	Yes	OF-130	Fecal coliform, total nitrogen	0	0.2	2.5	778	0.38	10.3	8.04	9.65		9	0.73	180	Soap suds and sheen in flow. High surfactants result. BMP contributing flow from upstream
OF-131	No			No	No															Outfall capped
OF-132	No			No	No															Other PVC pipes under dock with steady flow coming from direction of businesses
OF-133	No			No	No															
OF-134	Yes	Trickle	0.5	No	Yes	OF-134	Fecal coliform, total nitrogen	0	0.4	0.25	1545	0.78	6.8	8.44	14.69		10	0.76	10	Fecal Coliform result is <10
OF-135	No			No	No															Culvert with drainage connection. No flow in upstream catch basin. Shares headwall with OF-102
OF-136	No			No	No															
OF-137	No			No	No															Partially submerged but no flow in manhole. Erosion present around upstream manhole
OF-138	No			No	No															
OF-139	No			No	No															Outfall submerged, no flow in catch basin
OF-140	No			No	No															Pipe deteriorating
OF-141	No			No	No															Yard waste and trash dumping into BMP (see picture)
OF-142	No			No	No															Puddle in pipe but no flow
OF-143	Yes	Trickle	0.2	No	Yes	OF-143		0.35	0	0.25	348.6	0.17	7.4	8.38	12.33	67				
OF-144	No			No	No															Shares headwall with culvert and OF-145. Partially submerged, no flow in catch basin
OF-145	No			No	No															Shares headwall with culvert and OF-144
OF-146	No			No	No															Culvert with drainage connection, no flow confirmed in catch basins
OF-147	No			No	No															Channel was recently dredged (see picture)
OF-148	No			No	No															Outfall found ~250 feet from marked location. Position updated in Collector
OF-149	No			No	No															Discharges to BMP
OF-150	No			No	No															Sediment build up in conveyance causing erosion at outlet and surcharging during flow. Channel may overflow into yard during heavy flow event
OF-151	No			No	No															Invert wet but no flow. Discharges to swale along with private outfall from business parking lot
OF-152																				Pipe not located, overgrown vegetation
OF-153	No			No	No															Discharges to BMP
OF-154	No			No	No															
OF-155	No			No	No															
OF-156																				Channel and flagged stake in location but pipe not found
OF-157	No			No	No															
OF-158	No			No	No															Channelization with sediment deposits
OF-159	No			No	No															Culvert with drainage connection. No flow in catch basin



Legend

- | | | |
|--------------------|-----------------------------|-------------------------|
| ▲ Outfalls | — Storm Water Gravity Drain | — Roads |
| ■ Stormwater BMP | — Swale | — Lake, Pond, Reservoir |
| ■ Catch Basin | ■ Pump Station | — Wetland, Marsh, Swamp |
| ● Drainage Manhole | — Sewer Force Main | — Stream, Brook |
| — Culvert | — Sewer Pipe | — Non-Urban Area |



Stormwater Infrastructure Map
Barnstable, MA

Comprehensive
Environmental
Incorporated



Data Sources: CEI, MassGIS, Town of Barnstable

Illicit Discharge Log

Date	Outfall ID	Outfall Location	Description of Discharge	Description of Discovery	Source of Discharge	Date of Mitigation	Planned Corrective Actions	Estimated volume of Flow Removed

Illicit Discharge Tracking Form

Outfall ID:	
Outfall Location:	
Description of Discharge:	
Description of Discovery (Methods used):	
Source of Discharge:	
Date of Discovery:	Date of Mitigation (if corrected):
Planned Corrective Actions (with schedule):	
Estimated Volume of Flow Removed:	

Appendix I

IDDE Employee Training Records

